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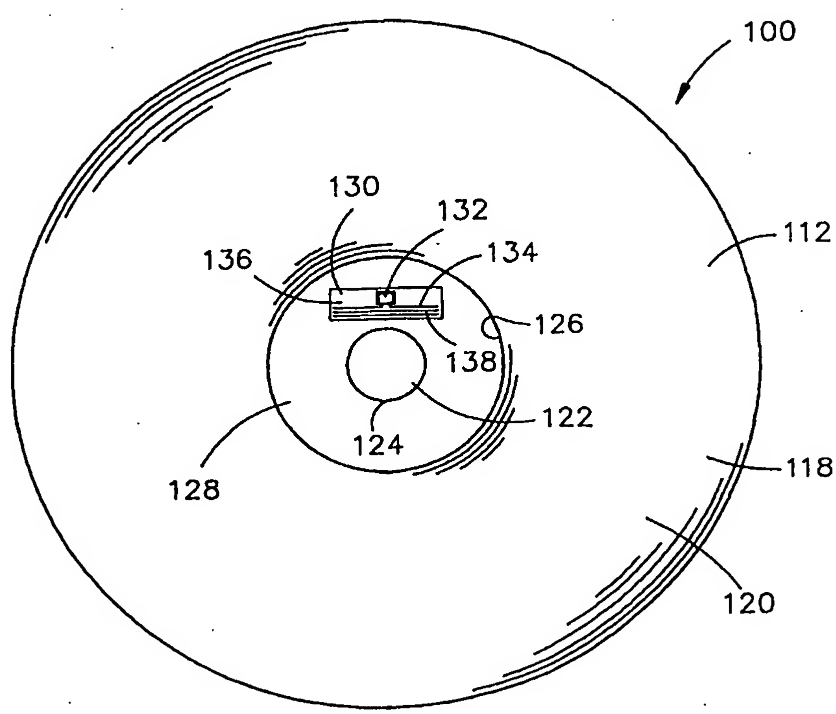
(54) Title: SMART OPTICAL STORAGE MEDIA

(57) Abstract

An optical storage medium is disclosed. The optical storage medium comprises an optical disc (100) which includes integral information storage (112) and communication apparatus (130) for storing and communicating information to an external system. The information storage and communication apparatus comprises a circuit (132) including memory for storing information and a communication device (134) for communicating the information with the external system.



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SMART OPTICAL STORAGE MEDIA

Cross-Reference to Related Applications

The present application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Application No. 60/104,667, filed October 16, 1998. Said U.S. Provisional Application No. 60/104,667 is herein incorporated by reference in its entirety.

Incorporation by Reference

The following US Patents and Patent Applications are hereby incorporated herein by reference in their entirety:

U.S. Patents

Patent Nº	Issue Date	Filing Date	Attorney Docket Nº
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08/646,539	05/08/96	YO996-068
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08/694,606	08/09/96	YO995-218
08/790,639	01/29/97	YO997-024
08/790,640	01/29/97	YO997-023
08/733,684	10/17/96	YO996-195
08/862,149	05/23/97	YO997-116
08/862,912	05/23/97	YO997-115
08/862,913	05/23/97	YO997-114
08/909,719	08/12/97	YO995-109B (allowed)
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EH 372 217 464 US	07/10/98	YO896-0212R1
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Application Nº	Filing Date	Attorney Docket Nº
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60/073,102	01/30/98	YO897-0028P1
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60/078,100	03/16/98	YO897-0657P1
60/078,226	03/16/98	YO897-0658P1
60/078,287	03/17/98	YO897-0661P1
60/091,350	07/01/98	YO897-0259P2
60/078,304	03/17/98	YO897-0662P1
60/090,637	06/25/98	YO896-0212P2
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60/099,298	09/04/98	YO894-0206P3
EI 837 644 898 US	09/17/98	38402P1

The following further documents are also incorporated herein by reference in their entirety:

IBM Technical Disclosure Bulletin

IBM Technical Disclosure Bulletin: Vol. 38 Nº 08, August 1995, page 17, "Multifunction Credit Card Package," by Brady, Moskowitz, and Murphy (published pseudonymously).

Literature Reference

D. Friedman, H. Heinrich, D. Duan, "A low-power CMOS integrated circuit for field-powered radio frequency identification (RFID) tags," 1997 Digest of Technical Papers of the IEEE International Solid-State Circuits Conference (ISSCC), San Francisco, CA, February 1997.

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Application Nº	Filing Date	Attorney Docket Nº
PCT/GB96/00061	01/15/96	UK 9-94-066 PCT
PCT/EP95/03703	10/20/95	YO994-242 PCT

UK Published Application

Application Nº	Filing Date	Attorney Docket Nº
9710025.9	05/19/97	YO9-96-084

Field of the Invention

The present invention relates generally to optical storage media (i.e., optical discs including compact disc (CD), compact disc read only memory (CD-ROM), digital versatile (video) disc (DVD), laserdisc, etc.), and more specifically to smart optical storage media having information storage and communication apparatus and methods for their use.

Background of the Invention

Optical storage media such as optical discs provide high density, digital storage of information and data in computer, video, and audio applications. Often, optical discs contain information (i.e., movies, music, computer programs, games, etc.) which may be proprietary or which may be subject to copyright protection. For this reason, such optical discs are subject to theft or unauthorized copying (e.g., counterfeiting). Further, optical discs are capable of holding an extremely large amount of information. Thus, optical discs often contain information which may be viewed (or heard) by a wide audience as well as information which is meant for more limited groups. For example, optical discs may contain information (i.e., movies, songs, games, etc.) capable of being viewed by audiences of all ages as well as information which should only be viewed by adults. Similarly, an optical disc may contain information of a sensitive or proprietary nature which is to be viewed only by certain persons within an organization.

Consequently, it would be advantageous to provide a smart optical disc which includes a means of authentication that is secure against theft or counterfeit. The smart optical disc could include index information which could be used to enable or disable the use of sections of the disc and could be capable of storing data such as a record of usage of the disc's contents.

Summary of the Invention

Accordingly, the present invention is directed to a novel optical storage media comprising an optical disc which includes integral information storage and communication apparatus for storing and communicating information to an external system. The information storage and communication apparatus comprises a circuit including memory for storing information and a communication device for communicating the information with the external system.

In an exemplary embodiment, the circuit comprises a radio frequency identification (RFID) transponder laminated between the outer protective layers of the optical disc. The RFID transponder includes a radio frequency identification integrated circuit (RFID IC) having memory for storing information coupled to an antenna. The RFID transponder may be utilized by external systems to provide functions such as authentication of the disc, indexing of information recorded to the disc, enablement/disablement of the disc, recording of the number of times the disc has been played, and the like.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention claimed. The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate an embodiment of the invention and together with the general description, serve to explain the principles of the invention.

Brief Description of the Drawings

The numerous objects and advantages of the present invention may be better understood by those skilled in the art by reference to the accompanying figures in which:

FIG. 1 is a top plan view of an optical disc having an prefabricated RFID transponder;

FIG. 2 is a cross-sectional view of the optical disc shown in FIG. 1;

FIG. 3 is a top plan view of an optical disc having a prefabricated RFID transponder wherein the data storage layer is utilized as a conducting ground plane;

FIG. 4 is a cross-sectional view of the optical disc shown in FIG. 3;

FIG. 5 is a top plan view of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within its annular non-storage area wherein the antenna is a dipole antenna;

FIG. 6 is a top plan view of the annular non-storage area of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the area wherein the antenna is a conforming loaded dipole antenna;

FIG. 7 is a cross-sectional view of the optical discs shown in FIGS. 5 and 6;

FIG. 8 is a top plan view of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within its annular non-storage area wherein the antenna is a meander dipole antenna;

FIG. 9 is a top plan view of the annular non-storage area of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the area wherein the antenna is a conforming meander antenna;

FIG. 10 is a top plan view of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the area wherein the antenna is a loop antenna;

FIG. 11 is a top plan view of the annular non-storage area of an optical disc illustrating an alternative loop antenna geometry;

FIG. 12 is a top plan view of the annular non-storage area of an optical disc illustrating an alternative loop antenna geometry;

FIG. 13 is a top plan view of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within its annular non-storage area wherein the antenna is a spiral antenna;

FIG. 14 is a top plan view of the annular non-storage area of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the area wherein the antenna is a circular slot antenna;

FIG. 15 is a top plan view of the annular non-storage area of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the area wherein the antenna is a curvilinear slot antenna;

FIG. 16 is a top plan view of the annular non-storage area of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the area wherein the antenna is a split monopole antenna;

FIG. 17 is a top plan view of the annular non-storage area of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the disc wherein the antenna is a split monopole antenna;

FIG. 18 is a top plan view of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the disc wherein the antenna is a linearly polarized patch antenna;

FIG. 19 is a top plan view of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the disc wherein the antenna is a circularly polarized patch antenna;

FIG. 20 is a top plan view of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the disc wherein the antenna is a conforming patch antenna;

FIG. 21 is a top plan view of the annular non-storage area of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and

antenna integrated within the area wherein the antenna is an annular patch antenna;

FIG. 22 is a cross-sectional view of the optical discs shown in FIGS. 18, 19, 20 and 21;

FIG. 23 is a top plan view of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the disc wherein the data storage layer is utilized as part of the antenna;

FIG. 24 is a cross-sectional view of the optical disc shown in FIG. 23;

FIG. 25 is a top plan view of an optical disc having a radio frequency identification integrated circuit (RFID IC) chip and antenna integrated within the disc wherein the data storage layer is utilized as part of the antenna;

FIG. 26 is a top plan view of an optical disc having a radio frequency identification integrated circuit (RFID IC) and conforming patch antenna integrated within the disc wherein the data storage layer is utilized as the ground plane for the antenna;

FIG. 27 is a cross-sectional view of the optical disc shown in FIG. 26;

FIG. 28 is a top plan view of an optical disc having a radio frequency identification integrated circuit (RFID IC) and patch antenna integrated within the disc wherein the data storage layer is utilized as the ground plane for the antenna;

FIG. 29 is a top plan view of an optical disc having circuit including memory interconnected with a surface contact connector disposed on the surface of the optical disc;

FIG. 30 is a block diagram illustrating a system for playing and/or recording optical discs in accordance with the present invention;

FIG. 31 is a perspective view illustrating a system for interrogating optical discs of the present invention in a point of sale environment;

FIG. 32 is a perspective view further illustrating the hand-held interrogator and an optical disc as shown in FIG. 21;

FIG. 33 is a perspective view illustrating a system for interrogating optical discs of the present invention wherein the optical discs are crated for shipping; and

FIG. 34 is a top plan view of an alternative system for interrogating optical discs wherein the discs are crated for shipping.

Detailed Description of the Invention

The present invention provides an optical disc having an integral information storage and communication apparatus for storing and communicating information to an external system. The information storage and communication apparatus comprises a circuit including memory for storing information and a communication device for communicating the information between the circuit and the external system. The circuit is laminated between the outer protective layers of the optical disc so that it is protected from damage and can not be removed from the disc without physically altering or damaging the disc itself.

Referring now to FIGS. 1 through 29, optical discs in accordance with exemplary embodiments of the present invention are shown. The optical discs **100** may comply with any of numerous established formats, formats which are presently proposed or in development, or formats which may be proposed and developed in the future. Such formats include, but are not limited, to audio Compact Disc (CD), Compact Disc-Read Only Memory (CD-ROM), Readable/Writeable Compact Disc (i.e., CD-R, CD-RW formats), Digital Versatile (Video) Disc (i.e., DVD, DVD-ROM, DVD-R, DVD-RW, DVD-RAM formats), PhotoCD, Laserdisc, etc.

Such optical discs **100** typically include one or more data storage layers **112** (one is shown) sandwiched between distal outer protective layers **114** & **116**. Each data storage layer **112** comprises an annulus **118** formed of metal (typically aluminum) or a metallized material having at least one polished surface **120** capable of reflecting laser light emitted from an optical disc playing

apparatus [hereinafter optical disc drive]. Information may be physically inscribed onto the surface **120** in the form of a spiral shaped track of pits and lands. In this manner, the information may be digitally recorded to the optical disc **100**. The data storage layer **112** is laminated between the first and second outer layers **114** & **116**. The outer layers **114** & **116** may be made of a transparent plastic to allow laser light from the optical disc drive to penetrate to the reflective surface (or surfaces) of the data storage layer **112**. A circular aperture **122** may extend through the disc **100** at its center. The aperture **122** allows a drive mechanism (not shown) within the optical disc drive to engage and spin the disc **100**. Typically, the perimeter **124** of the aperture **122** and the inner edge **126** of the annulus **122** define a annular non-storage area **128** which does not contain optically encoded data (the data storage layer **122** does not extend into the area **128**).

As shown in FIGS. 1 through 28, the information storage and communication circuit may comprise a radio frequency identification (RFID) transponder **130** laminated between the outer layers **114** & **116** of the optical disc **100**. The RFID transponder **130** may communicate with an external system (i.e., an optical disc player, an optical disc recorder, an RFID system, etc.) to provide functions such as authentication of the optical disc **100**, indexing of information recorded to the optical disc **100**, enablement/disablement of playback the optical disc **100** by a disc drive, tracking of the number of times the disc **100** has been played, and the like.

The RFID transponder **130** comprises a low power radio frequency identification integrated circuit (RFID IC) **132** including a signal processing section and an RF processing section (typically referred to as a front end) interconnected to an antenna **134**. The front end includes interface circuitry which provides the facility to direct and accommodate the interrogation field energy for powering purposes in passive transponders and triggering of the transponder response. The front end can be any known front end design used with an antenna. Examples of front ends are well known. See, for

example, the Hewlett Packard "Communications Components GaAs & Silicon Products Designer's Catalog" (i.e., page 2-15) which is herein incorporated by reference in its entirety. A typical front end is also described in U.S. Patent Application Serial No. 08/790,639 to Duan, et al. filed January 29, 1997 which is herein incorporated by reference in its entirety. The signal processing section may comprise control and processing circuitry and memory. Typical memory may include, for example, read-only memory (ROM), random access memory (RAM), and non-volatile programmable memory for data storage. Read only memory (ROM) may be used to accommodate security data and the transponder operating system instructions which, in conjunction with the processing circuitry provides functions such as response delay timing, data flow control and power supply switching. Random access memory (RAM) may be used to facilitate temporary data storage during transponder interrogation and response. Non-volatile programmable memory may be used to store transponder data so the data is retained when the transponder **130** is in a quiescent or power-saving "sleep" state or not powered at all. Data buffers may be provided to temporarily hold incoming data following demodulation and outgoing data for modulation and interface with the antenna **134**.

The RFID transponder **130** may be field powered (e.g., passive). Field powered transponders collect power from the RF field generated by the interrogator or base station and convert the collected power to a DC voltage which is stored in a capacitor to provide power for operating the transponder's other circuitry. Alternatively, the RFID transponder **130** may utilize a power source (i.e., a battery) interconnected to the RFID IC **132**.

The RFID IC **132** may be coupled to an antenna **134** which provides a means by which the transponder **130** senses the interrogating field (and/or, where appropriate, a programming field). The antenna **134** also serves as the means of transmitting the transponder response to interrogation. The RFID IC **132** and antenna **134** are preferably laminated between the outer layers **114** & **116** of the optical disc **100**. This prevents removal of the RFID transponder

130 without physical alteration (i.e., delamination, cutting, breaking, cracking, etc.) of the disc **100**. Typically, such physical alteration will be observable upon inspection or will render the disc **100** unusable (e.g., unplayable by an optical disc drive).

Referring now to FIGS. 1, 2, 3, and 4, the RF transponder **130** may be a preassembled RFID transponder which is embedded or laminated between the outer layers **114** & **116** as the disc **100** is assembled. The RFID IC **132** may be mounted to a substrate **136** and bonded to an antenna **134** formed on the substrate **136**. Typical substrate materials include polyester, polyimide, ceramics, FR-4 circuit board material, etc. The RFID IC **132** may be coated with an encapsulant, such as a "glob-top" epoxy, or the like which protects the circuit **132** (and bonds between the antenna **134** and circuit **132**) from damage. An aperture or cavity (not shown) may be formed in the substrate **136** allowing the insertion of the RFID IC **132** therein. In this manner, the thickness of the substrate **136** is not unnecessarily added to the thickness of the RFID IC **132** so that the overall cross-sectional profile of the RF transponder **100** is reduced and will not cause a bump on the surface of the optical disc **100**.

The antenna **134** may be integrally formed on the substrate **136**. Preferably, the antenna **134** consists of a thin pattern (typically 18 to 35 micron thick) formed of a conductive metal such as copper. This pattern may be formed by plating or adhering or screening a thin layer of copper (or other conductive metal) onto to the substrate **136**. The layer is then be etched to form the specific geometric configuration of the antenna **134** (a dipole antenna is shown in FIGS. 1 and 3; however, any antenna configuration, i.e., dipole, folded dipole, loop, coil, spiral, meander, patch, etc., may be formed). Similarly, one or more impedance adjustment elements **138** may be integrally formed on the substrate **136** to modify the impedance of the antenna **134**. The impedance adjustment elements **138** may be lumped circuit elements, distributed microwave circuit elements, or parasitic elements that are electromagnetically coupled to the antenna (i.e., not electrically connected).

Often, antennas **134** which are employed by such RFID transponders **130** include a conductive ground plane (not shown). As shown in FIG. 1 and 2, the RFID transponder **130** may be located within the annular non-storage area **128** of the optical disc **100**. For this embodiment, the conductive ground plane may comprise a layer of a conductive metal (e.g., copper) formed (i.e., by plating, adhering or screening, etc.) on the side of the substrate **136** opposite the pattern. Alternatively, as shown in FIGS. 3 and 4, in single sided discs **100** such as audio CD's, CD-ROM's, etc., the RFID transponder **130** may be positioned between an outer layer **114** and the non-storage ("label") surface **136** of the data storage layer (or layers) **112** (e.g., annulus **118**). The substrate of the RFID transponder **130** may space the antenna's radiator element (e.g., a dipole, patch element, etc.) from the data storage layer **112** so that the annulus **118** may form the conducting ground plane of the antenna **134**.

Referring now to FIGS. 5 through 28, the RFID transponder **132** may be formed within the optical disc **100** as it is assembled (e.g., without a separate substrate **136** as shown in FIGS. 1 through 4). The antenna **134** of the RFID transponder **130** may be integrally formed on a first of the outer layers (e.g., outer layer **116**). Preferably, the antenna **134** consists of a thin (typically 18 to 35 micron thick) pattern formed of a conductive metal such as copper. This pattern may be formed by plating, adhering, or screening a thin layer of copper (or other conductive metal) onto to the protective layer **116**. This thin copper layer may then be etched to form the specific geometric configuration of the antenna **134** (i.e., dipole, conforming dipole, meander dipole, conforming meander dipole, loop, spiral, circular slot, curvilinear slot, monopole, patch, etc.). Similarly, one or more impedance adjustment elements **138** may be integrally formed on the substrate **136** to modify the impedance of the antenna **134**. The impedance adjustment elements **138** may be lumped circuit elements, distributed microwave circuit elements, or parasitic elements that are electromagnetically coupled to the antenna (i.e., not electrically connected).

An RFID IC **132** may be bonded to the antenna **134** formed on the first protective layer **114** via conventional means such as wire bonding or the like. The RFID transponder **130** (e.g., RFID IC **132**, antenna **134**, impedance adjustment elements **138**, etc.) may then be laminated between the first outer layer **114** and the outer protective layer **116** or an insulating layer **140** (see FIG. 22 wherein the RFID transponder **130** utilizes a separate conducting ground plane **142**, or FIG. 27 wherein the RFID transponder **130** utilizes the data storage layer **112** as a conducing ground plane).

Preferably, as shown in FIGS. 7, 22, and 24, the components forming the RFID transponder **130** (i.e., RFID IC **132**, antenna **134**, impedance adjustment elements **138**, insulating layer **140**, conducting ground plane **142**, etc.) are made sufficiently thin so they may be embedded between the outer layers **114** & **116** without substantially increasing the thickness of the optical disc **100**. Further, the outer layers **114** & **116** may be formed so that the thickness of the RFID transponder **130** laminated or embedded there between is accommodated (i.e., within a shallow recess molded into one or both protective layers **114** & **116**.

Depending on the RF properties desired, RFID transponders **130** of the present invention may employ any of an almost unlimited number of different antennas **134** having various configurations and geometries. Several of the many possible antennas **134** which may be employed by the present invention are shown in FIGS. 5 through 28 and will now be described in detail by way of example. It should be apparent that reconfiguration of any of the antennas **134** shown herein, or substitution of other types of antennas by one skilled in the art would not depart from the scope and spirit of the invention.

Referring now to FIGS. 5 through 22, the RFID transponder **130** may be formed within the annular non-storage area **128** of the optical disc **100**. This configuration may be especially desirable wherein data is stored on both sides of the optical disc **100** (e.g., the optical disc **100** has a dual sided data storage layer **112** or two oppositely facing data storage layers **112**). For such optical

discs **100**, placement of the RFID transponder **130** over one of the data storage layers **112** could result in less than optimum use of the data storage capacity of the disc **100**.

Optical discs **100** having RFID transponders **130** employing dipole antennas are illustrated in FIGS. 5, 6, 7 and 8. As shown in FIG. 5, the antenna **134** may be a linear simple dipole antenna **144** comprising first and second linear (non-curved) dipole elements **146** & **148**. Alternatively, as shown in FIG. 6, the antenna **134** may be a conforming dipole antenna **150** having dipole elements **152** & **154** which are curved to conform to the inner perimeter **126** of the data storage layer **112** (e.g., annulus **118**). By curving the dipole elements **152** & **154**, the conforming dipole antenna **150** may be made to have a longer length than the linear dipole antenna **144** shown in FIG. 5, while still fitting within the annular non-storage area **128**.

Similarly, as shown in FIG. 8, the antenna **134** may be a meander dipole antenna **156** comprising first and second linear (non-curved) meander dipole elements **158** & **160**. Alternatively, as shown in FIG. 9, the antenna **134** may be a conforming meander dipole antenna **162** having meander dipole elements **164** & **166** which are curved to conform with the inner edge **126** of the data storage layer **112** (e.g., annulus **118**). The curved meander dipole elements **164** & **166** allow the conforming meander dipole antenna **162** to have a longer length than the linear meander dipole antenna **156** shown in FIG. 8, while still fitting within the annular non-storage area **128**.

As shown in FIGS. 5, 6 and 9, one or more impedance adjustment elements **138** may be integrally formed on the on the protective layer **116** to modify the impedance of the antenna **132**. The impedance adjustment elements **138** may be lumped circuit elements, distributed microwave circuit elements, or parasitic elements that are electromagnetically coupled to the antenna (i.e., not electrically connected). By way of example, the RFID transponder **130** may include a tuning stub **168** having a length and width adjusted to tune the impedance of the antenna **134**. The tuning stub **168** acts

as a two conductor transmission line and may be terminated either in a short-circuit or open-circuit. A short circuited stub acts as a lumped inductor while an open-circuit stub acts as a lumped capacitor. The magnitude of the reactance of the tuning stub **168** is affected by the stub's length, width, and spacing. Similarly, one or more impedance loading bars **170** may be positioned adjacent to the dipole antenna **134** so they are electromagnetically coupled to the antenna **132** to modify its impedance. The loading bars **170** may be straight as shown in FIG. 5, or curved to conform to the shape of the antenna **134** and fit within the annular non-storage area **128** of the optical disc **100** as shown in FIGS. 6 and 9. Use of tuning stubs and impedance loading bars to adjust the impedance of an antenna is described in detail in U.S. Patent Application Serial No. 08/790,639 to Duan, et al. filed January 29, 1997 which is herein incorporated by reference in its entirety.

Exemplary loop antennas are shown in FIGS. 10, 11, and 12. Preferably, each loop antenna **172, 174** & **176** comprises a loop shaped pattern (i.e., circular, square, rectangular, semi-circle, etc.) of a conductive metal such as copper which is integrally formed on the inner surface on the protective layer **116**. Alternatively, the loop antenna **172, 174** & **176** may be formed from a thin wire fashioned in the shape of a loop, bonded to the RFID IC **132** and laminated between the outer layers **114** & **116** of the optical disc **100** within the annular non-storage area **128**. FIG. 10 depicts a closed loop antenna **172** while FIGS. 11 and 12 illustrate open loop antennas **174** & **176**.

Referring now to FIG. 13, the antenna **134** may be a spiral antenna **178**. Preferably, the spiral antenna **178** comprises a spiral pattern of a conductive metal such as copper which may be integrally formed on the inner surface on the protective layer **116**. Alternatively, the spiral antenna **178** may comprise a thin wire which is spiraled around the center aperture **122**. The wire is bonded to the RFID IC **132** and laminated between the outer layers **114** & **116** within the annular non-storage area **128** of the optical disc **100**.

Referring now to FIGS. 14 and 15, exemplary slot antennas **180** & **182**

are illustrated. A circular slot antenna is shown in FIG. 14. The circular slot antenna **134** preferably comprises inner and outer annular antenna elements **184** & **186** embedded or laminated between the outer layers **114** & **116** within the annular non-storage area **128** of the optical disc **100**. A space or "slot" **188** is formed between the inner and outer annular antenna elements **184** & **186**. The RFID IC **132** is positioned within the slot **188** and interconnected (e.g., bonded) to each element **184** & **186**. Alternately, as shown in FIG. 15, the antenna **134** may be a curvilinear slot antenna **182** comprising first and second curvilinear antenna elements **190** & **192**. Preferably, the first and second curvilinear antenna elements **190** & **192** are embedded or laminated between the outer layers **114** & **116** and oriented so that a slot **194** is formed between them. The RFID IC **132** may be positioned within the slot **194** and interconnected (e.g., bonded) to each element **190** & **192**.

Turning now to FIGS. 16 and 17, exemplary split monopole antennas **196** & **198** are illustrated. The split monopole antennas **196** & **198** may include a generally circular antenna element **200** & **202** embedded or laminated between the outer layers **114** & **116** within the annular non-storage area **128**. Various impedance adjustment elements **138** may be utilized to tune the impedance of the split monopole antennas **196** & **198**. Such impedance adjustment elements **138** may include, but are not limited to, notches **204** formed in the antenna element **200** or distributed elements **206**, **208**, **210** & **212** interconnected to the RFID IC **132** or antenna element **200** & **202**, or electromagnetically coupled to the antenna **196** & **198**. It should be appreciated that many impedance adjustment element configurations, geometries, and placements are possible. Consequently, modification of the antennas **196** & **198** shown in FIGS. 16 and 17 by one skilled in the art to utilize other impedance adjustment elements would not depart from the scope and spirit of the invention.

Referring now to FIGS. 18, 19, 20, 21, and 22, the antenna **134** may be a patch antenna. Typical patch antennas which may be utilized with the present

invention include, but are not limited to, patch antennas having conventional geometries such as the linearly polarized patch antenna **214** shown in FIG. 18 and circularly polarized patch antenna **216** shown in FIG. 19, or alternatively, application specific geometries (e.g., geometries tailored to fit within a circular or disk shaped area) such as the conforming patch antenna **218** shown in FIG. 20 and the annular patch antenna **220** shown in FIG. 21. Such patch antennas **214, 216, 218** & **220** may include a patch element **222**, one or more impedance adjustment elements **138** and a conducting ground plane **142** (FIG. 22) laminated between the outer layers **114** & **116** of the optical disc **100** within the annular non-storage area **128**. As shown in FIG. 22, the patch element **222** and impedance adjustment elements **138** are preferably separated from the conducting ground plane **142** by an insulating layer or substrate **140**.

Referring now to FIGS. 23, 24, and 25, the metal or metallized annulus **118** forming the data storage layer **112** of the optical disc **100** may be used as at least part of the antenna of the RFID transponder **130**. As shown in FIG. 23 and 24, the RFID IC **132** may be bonded directly to the annulus **118** and laminated between the outer layers**114** & **116** within the annular non-storage area **128** of the optical disc **100**. As shown in FIG. 25, one or more impedance adjustment elements **138** may be formed within the annular non-storage area **128** of the optical disc **100** to adjust the impedance of the antenna **134** (e.g., annulus **118**). The data storage layer **112** may also be used as a parasitic loading element for a dipole or meander dipole antenna (i.e., in place of impedance loading bars **170** shown in FIGS. 5 and 6).

Turning now to FIGS. 26, 27 and 28, the metal or metallized annulus **118** may form the conducting ground plane of the antenna **134** (wherein the antenna requires a ground plane). The antenna **134** may, for example, be a patch antenna **224** & **226** including a patch element **228** and one or more impedance adjustment elements **138** suspended over a conducting ground plane. Preferably, the patch element **228** and impedance adjustment elements **138** are embedded or laminated between a first outer layer **114** of the optical

disc **100** and an insulating layer **140**. The annulus **118** is similarly embedded or laminated between the insulating layer **140** and a second outer layer **118** so that the patch element **228** and impedance adjustment elements **138** are physically separated from the annulus **118** by the insulation layer **140**.

As shown in FIG. 26, the antenna **134** may be a conforming circular patch antenna **224** having a generally curved overall shape which conforms to the curvature of the annulus **118**. In this manner, the area of the patch element **228** and impedance adjustment elements **138** may be increased so that utilization of the surface area of the annulus **118** as the ground plane of the antenna **134** is optimized.

Components of the RFID transponder **130** which are interconnected with the patch element **228** may optionally be positioned within the annular non-storage area **128** of the optical disc **100**. For example, in FIG. 28, the RFID IC **132** is located within the annular non-storage area **128** and interconnected to patch element **228** (which is formed over the annulus **118**). Similarly, impedance adjustment elements (i.e., impedance matching circuits **230** & **232**) may be positioned either over the annulus (e.g., impedance matching circuit **230**) or within the annular non-storage area **128** (e.g., impedance matching circuit **232**). However, wherein the impedance adjustment elements **138** are located within the annular non-storage area **128** of the optical disc **100**, a second conducting ground plane (not shown) may be required. Referring now to FIG. 29, an optical disc **100** in accordance with an alternative embodiment of the present invention is shown. The information storage and communication circuit of this optical disc **100** may comprise an integrated circuit (IC) **250** embedded or laminated between the outer layers **114** & **116** of the optical disc **100**. The IC **250** may be interconnected to electrical contacts **252** mounted to the surface of the disc **100** within the annular non-storage area **128**. Preferably, the IC **250** comprises control and processing circuitry and memory. Typical memory may include, for example, read-only memory (ROM), random access memory (RAM), and non-volatile programmable memory for

data storage. The electrical contacts **252** preferably allow the IC **230** to communicate with an external system (i.e., an optical disc player, an optical disc recorder, etc.) to provide functions such as authentication of the optical disc **100**, indexing of information recorded to the optical disc **100**, enablement/disablement of playback of the optical disc **100**, tracking of the number of times the optical disc **100** has been played, and the like. The electrical contacts **252** may also provide electrical power to the IC **250** for its operation.. Preferably, when the optical disc **100** is recorded or played, the contacts **252** mate with contacts on the drive of the player/recorder (not shown) so that information may be communicated between the IC **250** and an external system (see FIG. 30).

Further, the IC **250** may be an RFID IC and may be coupled to both the electrical contacts **252** and an antenna (such as any of the antennas shown in FIGS. 1 through 28). In this manner, information stored in the IC **250** may be read through either the contacts **252** or through the antenna (see FIGS. 1 though 28) via an RFID interrogator. The electrical contacts **252** and the antenna may be used at the same time or separately. For example, when used simultaneously, the electrical contacts **252** may be used by a driver to provide power to the IC **250** while the antenna may be used by an interrogator to read information. Alternatively, power may be transmitted through the antenna, and information through the electrical contacts **252**. When used separately, an RFID interrogator may be used at the point of sale of the disc **200**, or during a similar business process (i.e., inventory, delivery, etc.), to read information stored in the IC **250**. For example, the electrical contacts **252** may be used by a disc drive (i.e., in an audio CD player, compact disc drive, DVD player, etc.) to read information from the IC **250**. This would allow the disc drive to be made without an RFID interrogator, thereby reducing its cost and complexity.

Referring now to FIG. 30, a system **300** for playing (and/or recording) optical discs of the present invention is shown. In an exemplary embodiment, the system **300** includes a conventional player and/or recorder (e.g., a disc

drive) **302** for reading information from or writing information to the optical disc **100**, an interrogator **304** for communicating with the RFID transponder **130**, and a controller **306** which integrates operation of and controls data transfer via the player/recorder **302** and interrogator **304**. Memory **306** may also be provided for storing information (i.e., information read from the optical disc **100** or received from the RFID transponder **130**, information to be written to the optical disc **100** or RFID transponder **130**, data against which information received from the RFID transponder **130** may be compared, etc.).

Wherein the system **300** is used to play (e.g., read) an optical disc **100**, the interrogator **304** may interrogate the RFID transponder **130** by communicating a request for data contained within the transponder's memory. Preferably, the RFID transponder **130** responds to the transmitted request by communicating the requested information. This information may then be decoded and used by the controller **306** to control operation of the player **302**.

For example, the RFID transponder **130** may transmit a code, password, etc. which commands the controller **306** to allow the player to begin playback of the disc **100** by the system **300**. Preferably, unless this code is received by the interrogator **304**, the optical disc **100** could not be played by the player **302**. In this manner, the system **300** would provide a means of authenticating optical discs **100** to be played, thereby making them more secure against theft or counterfeiting.

Similarly, the system **300** could be used to prevent the optical disc **100** from being viewed by a particular audience. For example, the optical disc **100** may contain information (i.e., movies, music, etc.) which would be inappropriate for dissemination to a particular audience (i.e., children, employees lacking a security clearance, etc.). The system **300** could prevent an optical disc **100** containing such information from being played unless a security code is entered (i.e., by an adult, employee having an appropriate clearance, etc.) which matches a security code stored within the memory of the RFID transponder **130**.

The memory of the RFID transponder **130** may further include index information for the data stored on the optical disc **100**. When interrogated, the RFID transponder **130** would communicate this index information to the interrogator **304**. The index information could then be used to locate particular data or information stored on the disc **100**. Similarly, the index information could enable or disable access to sections of information stored on the optical disc **100**. In this manner, a single optical disc **100** may contain data or information which may be disseminated to a wide audience as well as information which is meant for more limited groups (i.e., classified and unclassified material, proprietary and non-proprietary data, R-rated and G-rated movies, etc.). The system **300** could interrogate the RFID transponder **130** to determine which material contained on the disc could be accessed by the particular audience using the system **300**.

The interrogator **304** may also be capable of writing information to the RFID transponder **130**. In this manner, information such as an access code for may be written to the RFID transponder **130** for enabling/disabling future playback of the optical disc **100**. Similarly, information may be written to the RFID transponder **130** during playback. For example, a record of the usage of the disc's contents may be stored to the memory of the RFID transponder **130**. The interrogator **304** may increment this record each time the optical disc **100** is played. Additional playback of the optical disc **100** could then be disabled after a predetermined number of plays.

It should be appreciated that the system **300** may include one or more electrical contacts (not shown) instead of (or in addition to) the interrogator **304** shown in FIG. 30. Preferably, these electrical contacts mate with contacts **232** of the optical disc **100** shown in FIG. 29 to allow communication between the IC **230** (FIG. 29) and the controller **306**.

Referring now to FIG. 31, 32, and 33, an exemplary RFID system utilizing optical discs in accordance with the present invention are shown. The RFID system **400** includes a hand-held interrogator or reader **402** (the

interrogator may be part of a hand-held data terminal, portable computer, etc.) for interrogating the RFID transponder **130** within the optical discs **100**. The interrogator reads information stored in the RFID transponder's memory. The interrogator **402** may, for example, communicate a request for data contained within the transponder's memory. Preferably, the RFID transponder **130** responds to the transmitted request by communicating the requested information. The information may then be decoded and used by the interrogator **402**.

As shown in FIG. 31 and 33, the RFID system **400** may, for example, be used in a retail, rental, or library environment. The RFID transponder **130** of each optical disc **100** may be programmed with inventory information identifying the optical disc **100** (i.e., content, serial number, inventory number, price, etc.). The interrogator **402** may interrogate each optical disc's transponder **130** to retrieve this information. In this manner, the disc **100** may be inventoried without being physically handling (e.g., removed from the shelf **404** as shown in FIG. 31 or unpacked from a shipping crate **406** as shown in FIG. 33). The inventory information may similarly be utilized to locate a particular optical disc from a group of discs.

As shown in FIG. 32, the RFID system **400** may similarly be used in point-of-sale applications. Inventory information stored in the memory of the RFID transponder **130** may be read by the interrogator **402** and used during sale, rental, loan, or return transactions of an optical disc **100** with a customer or patron. The information may be used to automate the transaction and/or may be provided to a central computer system to update inventory information. For example, when a customer wants to return a previously purchased disc **100** (i.e., an audio CD), a store clerk may utilize the interrogator **402** to read the RFID transponder **130** in the disc **100** to retrieve information such as, for example, when the disc **100** was purchased, the price paid for the disc **100**, whether the disc **100** was properly checked out (i.e., was not stolen), and the store from which the disc **100** was purchased.

The interrogator **402** may also be capable of writing or programming information to the memory of the RFID transponder **130**. For example, the RFID transponder **130** may be preprogrammed with a code which would disable playback of the optical disc **100** when played by a disc playing system such as the system shown in FIG. 30. The interrogator **402** may, at the time of sale, erase this code from the RFID transponder **130** so that the customer may play the optical disc **100** after purchase or rental. Alternatively, the interrogator **402** may write a code to the RFID transponder **130** which would allow playback of the optical disc **100**. In this manner, theft of RFID equipped optical discs **100** would be deterred since the stolen discs could not be played.

Referring now to FIG. 34, an RFID system **500** may be capable of automatically sorting crates or packages **502** containing optical discs of the present invention. The RFID system **500** may also automatically verify the contents of each crate **502**, enable/disable the RFID transponders of each optical disc contained within the crate **502**, etc., by reading information from (and/or writing or programming information to) the RFID transponder of the optical discs within the crate **502**.

The RFID system **500** includes a controller or base station **504** comprising an RF transceiver **506** coupled to one or more RF antennas **508**. The base station **504** may interrogate RFID transponders embedded within labels **510** adhered to the crates **502** as they are carried along the system's primary conveyor mechanism **512** past the antennas **508**. Memory contained by such RFID transponders may be programmed with destination and routing information for the crate **510** to which it is attached. The base station **504** may process this information so that the crate **510** may be automatically sorted and routed to the appropriate destination. This may be accomplished, in an exemplary embodiment, by temporarily closing a gate **514** across the primary conveyor mechanism **512**. The gate **514** causes the crate **502** to be diverted onto a secondary conveyor mechanism **516** corresponding to the destination and routing information contained within the RFID transponder of the " label

510.

Similarly, the base station **504** may also interrogate and/or program the RFID transponders of each optical disc contained within the crate **502** (see also FIG. 33). The optical discs' RFID transponders may, for example, be programmed with information identifying the optical disc (i.e., title, author, content, serial number, inventory number, price, etc.). The base station **504** may interrogate each optical disc's transponder to retrieve this information without physically handling the disc (e.g., removing it from the shipping crate **502**). The base station **504** may then use the information to verify whether each crate contains the proper number and type of optical discs.

The base station **504** may also be capable of writing or programming information to the memory of the RFID transponder of each optical disc within the crate **502**. For example, the base station **504** may program the transponder with inventory information for use by customers (i.e., serial number, title, index information, etc.). Similarly, the base station **504** could program the transponder with a code, password, etc. which would enable playback of the optical disc when played by a system such as the system shown in FIG. 30. Stolen or counterfeited optical discs would lack this coded information and thus could not be played by the system.

It is believed that the present invention and many of its attendant advantages will be understood by the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the components thereof without departing from the scope and spirit of the invention or without sacrificing all of its material advantages. The form herein before described being merely an explanatory embodiment thereof, it is the intention of the following claims to encompass and include such changes.

Claims

What is claimed is:

1. An optical storage medium, comprising:

an optical disc including first and second protective layers and a data storage layer disposed between said first and second protective layers, said data storage layer capable of storing optically readable information; and

a circuit disposed between said first and second protective layers adjacent to said data storage layer, said circuit including memory for storing information and a communication device for communicating the information with an external system.

2. The optical storage medium according to claim 1, wherein said circuit comprises an radio frequency identification (RFID) circuit.

3. The optical storage medium according to claim 1, wherein said circuit comprises an RFID transponder laminated between the first and second protective layers, the RFID transponder including:

an insulating substrate;

an antenna integrally formed on the substrate; and

a radio frequency identification integrated circuit (RFID IC) chip mounted to said substrate and interconnected with the antenna.

4. The optical storage medium according to claim 1, wherein said circuit comprises a radio frequency identification integrated circuit (RFID IC) interconnected with an antenna.

5. The optical storage medium according to claim 4, wherein the RFID IC and antenna are laminated between the first and second outer layers.

6. The optical storage medium according to claim 5, wherein the antenna has a dipole structure.

7. The optical storage medium according to claim 6, further comprising a tuning stub formed in the antenna for modifying the impedance of the antenna.

8. The optical storage medium according to claim 6, further comprising a loading bar electromagnetically coupled to the antenna for modifying the impedance of the antenna.

9. The optical storage medium according to claim 6, wherein the antenna is interconnected to the RFID IC via an impedance matching circuit.

10. The optical storage medium according to claim 4, wherein the antenna is a meander dipole antenna.

11. The optical storage medium according to claim 10, further comprising a tuning stub formed in the antenna for modifying the impedance of the antenna.

12. The optical storage medium according to claim 10, further comprising a loading bar electromagnetically coupled to the antenna for modifying the impedance of the antenna.

13. The optical storage medium according to claim 10, wherein the antenna is interconnected to the RFID IC via an impedance matching circuit.

14 The optical storage medium according to claim 4, wherein the antenna is a patch antenna.

15. The optical storage medium according to claim 14, wherein the patch antenna is a linear polarized patch antenna.

16. The optical storage medium according to claim 14, wherein the patch antenna is a circularly polarized patch antenna.

17. The optical storage medium according to claim 14, wherein the patch antenna is interconnected to the RFID IC via an impedance matching circuit.

18. The optical storage medium according to claim 14, wherein said data storage layer forms the ground plane of said patch antenna.

19. The optical storage medium according to claim 4, wherein the antenna is a loop antenna.

20. The optical storage medium according to claim 4, wherein the antenna is a spiral antenna.

21. The optical storage medium according to claim 4, wherein said optical disc includes a circular aperture centered therein, and wherein the data storage layer comprises a metal annulus coaxial with the circular aperture so that the perimeter of the circular aperture and the inner circumference of the metal annulus define a annular non-storage area on said optical disc.

22. The optical storage medium according to claim 21, wherein the RFID IC chip is laminated between the first and second protective layers within the circular non-storage area.

23. The optical storage medium according to claim 22, wherein the antenna is an patch antenna disposed within said circular non-storage area, said patch antenna having an annular patch element and ground plane.

24. The optical storage medium according to claim 22, wherein the antenna is a circular slot antenna disposed within said circular non-storage area.

25. The optical storage medium according to claim 22, wherein the antenna is a curvilinear slot antenna disposed within the circular non-storage area and having an outer edge extending along the inner edge of the data storage layer.

26. The optical storage medium according to claim 22, wherein the antenna is a dipole antenna disposed within the circular non-storage area and having a generally curved shape substantially conforming to the inner edge of the data storage layer.

27. The optical storage medium according to claim 26, further comprising an impedance loading bar electromagnetically coupled to the antenna and disposed within the circular non-storage area.

28. The optical storage medium according to claim 26, wherein the data storage layer provides impedance loading of the antenna.

29. The optical storage medium according to claim 22, wherein the antenna is a meander dipole antenna disposed within the circular non-storage area and having a generally curved shape substantially conforming to the inner edge of the data storage layer.

30. The optical storage medium according to claim 29, further comprising an impedance loading bar electromagnetically coupled to the antenna and disposed within the circular non-storage area.

31. The optical storage medium according to claim 25, wherein the data storage layer provides impedance loading of the antenna.

32. The optical storage medium according to claim 22, wherein the antenna is a split monopole antenna disposed within the circular non-storage area.

33. The optical storage medium according to claim 32, further comprising an impedance tuning element coupled to the antenna and disposed within the circular non-storage area.

34. The optical storage medium according to claim 22, wherein the metal annulus forms part of the antenna.

35. The optical storage medium according to claim 1, wherein the communication device comprises an electrical contact.

36. The optical storage medium according to claim 1, wherein the circuit comprises a radio frequency identification circuit and the communication device comprises an electrical contact and an antenna, and wherein said RFID circuit is interconnected to both the electrical contact and the antenna.

37. A system for playing an optical disc having an integral RFID transponder, comprising:

a drive for playing the optical disc;

a controller interconnected with said drive for controlling playback of the optical disc by said drive; and

an interrogator interconnected with said controller, said interrogator for communicating information with the RFID transponder.

38. The system in accordance with claim 37, wherein said controller uses information communicated to said interrogator from the RFID transponder to control playback of the optical disc by said drive.

39. The system in accordance with claim 38, wherein the information comprises authentication information for enabling and disabling playback of the optical disc by said drive.

40. The system in accordance with claim 38, wherein the information comprises content information for the optical disc for selectively enabling and disabling playback of a portion of the optical disc by said drive.

41. The system in accordance with claim 37, wherein the information includes index information for the optical disc.

42. A system for recording an optical disc having an integral RFID transponder, comprising:

a drive for recording information to the optical disc; and

a interrogator for programing the RFID transponder.

43. The system in accordance with claim 42, further comprising a controller interconnected with said drive and said interrogator for controlling recording of the optical disc by said drive and programming of the RFID transponder by said interrogator.

44. The system in accordance with claim 42, wherein said interrogator programs the RFID transponder with authentication information for enabling and disabling playback of the optical disc.

45. The system in accordance with claim 42, wherein said interrogator programs the RFID transponder with content information representing the content of the optical disc.

46. The system in accordance with claim 45, wherein the content information provides selective enabling and disabling of playback of a portion of the optical disc.

47. The system in accordance with claim 45, wherein the content information includes index information for the optical disc.

48. A radio frequency identification (RFID) system, comprising:

an interrogator having transmitting and receiving apparatus for communicating via radio frequency; and

an optical storage medium having a radio frequency identification (RFID) transponder integrally formed therein, said RFID transponder configured for communicating with the transmitting and receiving apparatus.

49. The system according to claim 48, wherein the circuit comprises an RFID transponder laminated between the first and second protective layers, the RFID transponder including:

an antenna; and

a radio frequency identification integrated circuit (RFID IC) interconnected with the antenna.

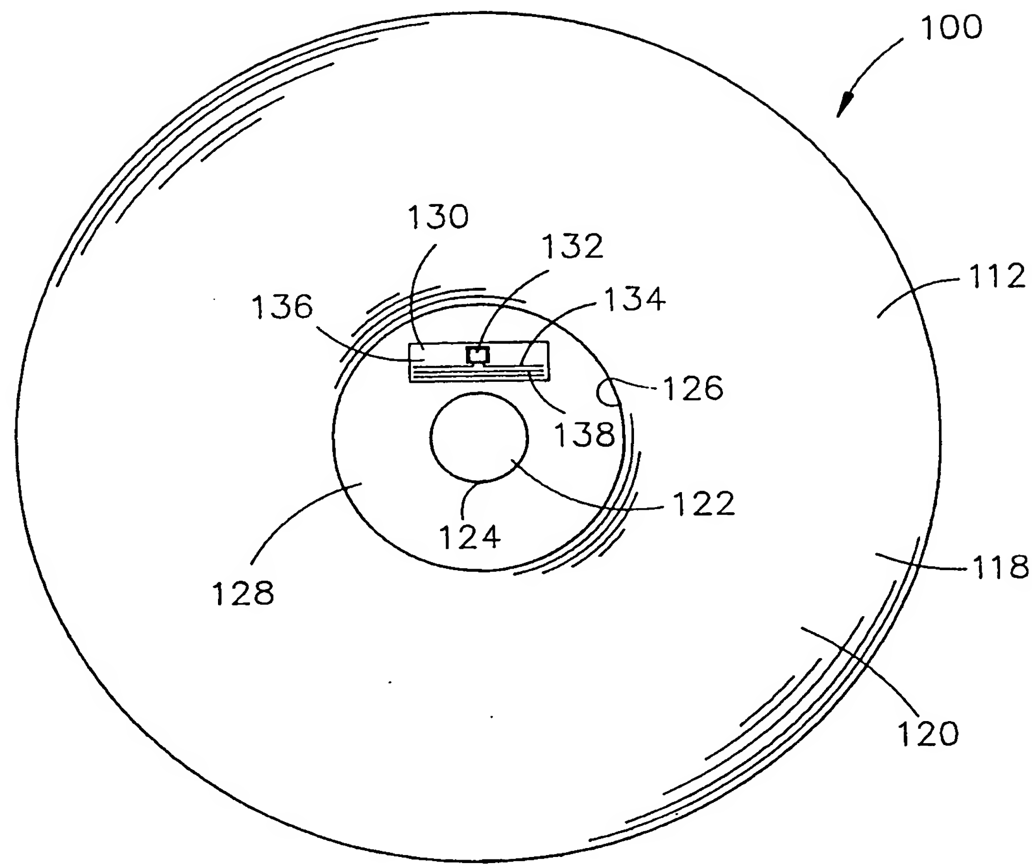
100
130
132
112
136
134
126
138
122
124
128
118
120

FIG. 1

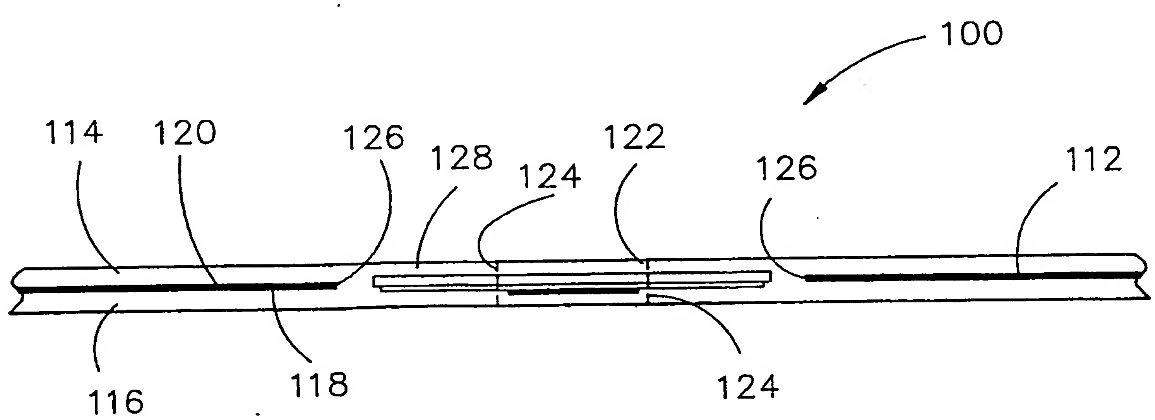
100
114
120
126
128
124
122
126
112
116
118
124

FIG. 2

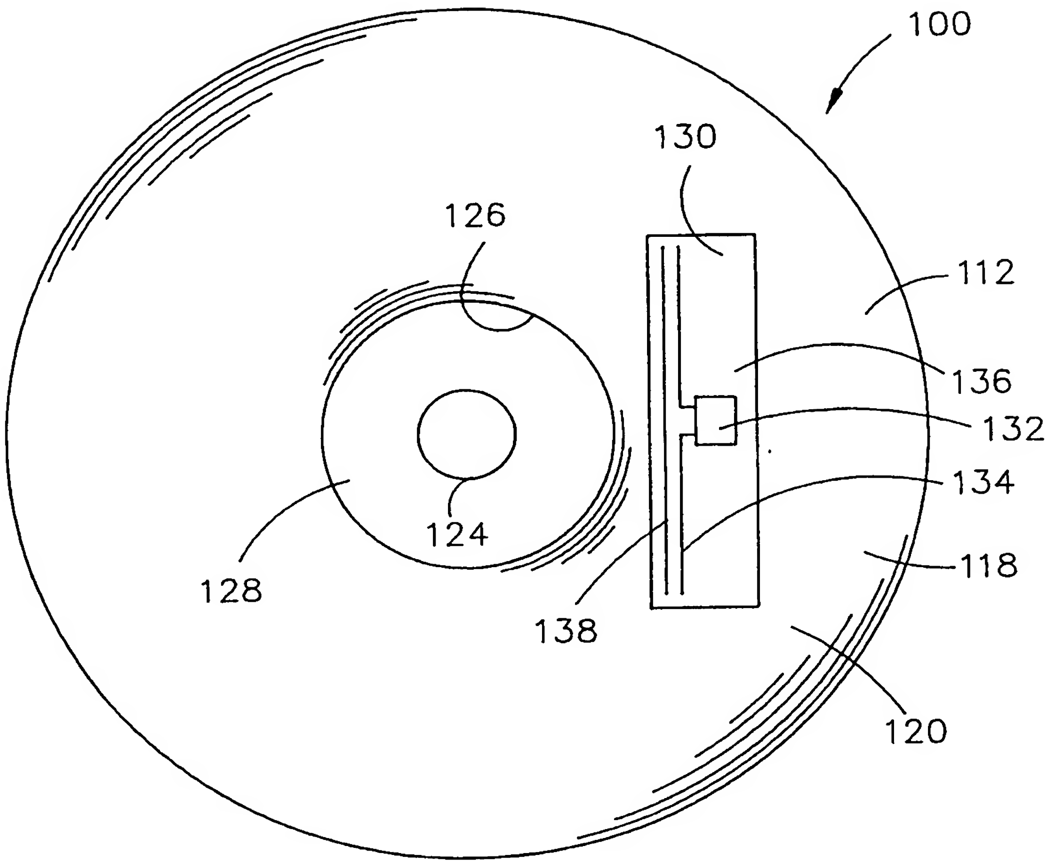
100
130
126
112
136
132
134
118
124
128
138
120

FIG. 3

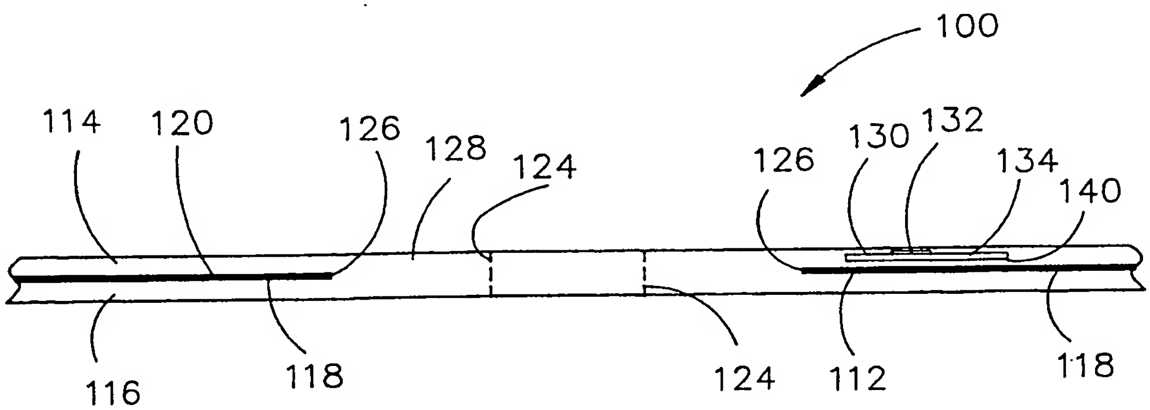
100
114
120
126
128
124
126
130
132
134
140
116
118
124
112
118

FIG. 4

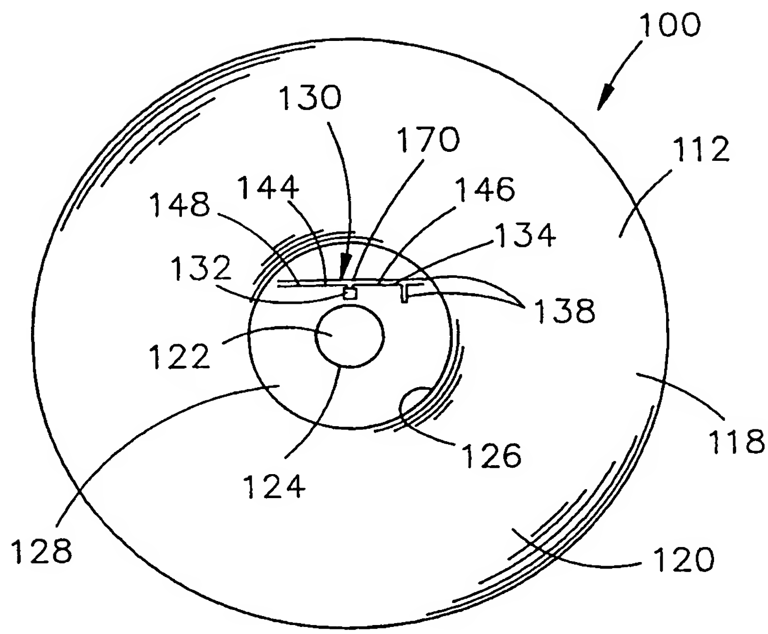

FIG. 5

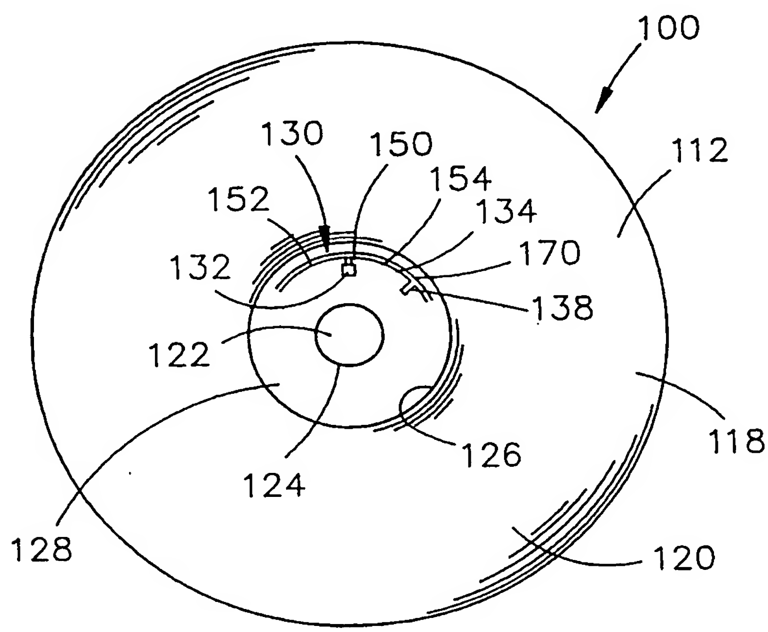

FIG. 6

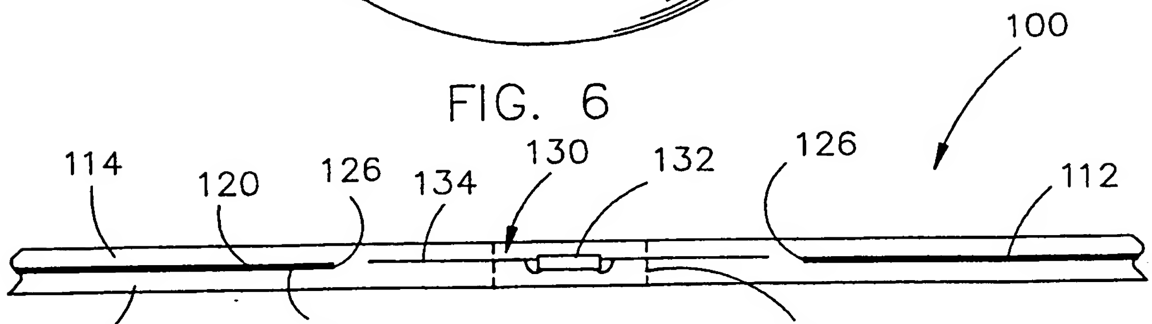

FIG. 7

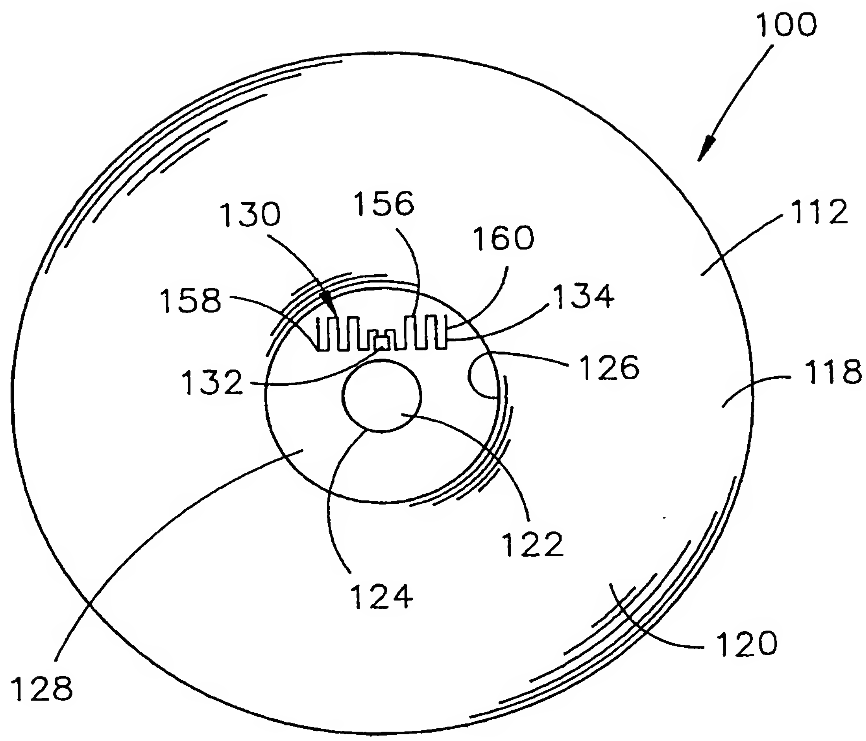
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FIG. 8

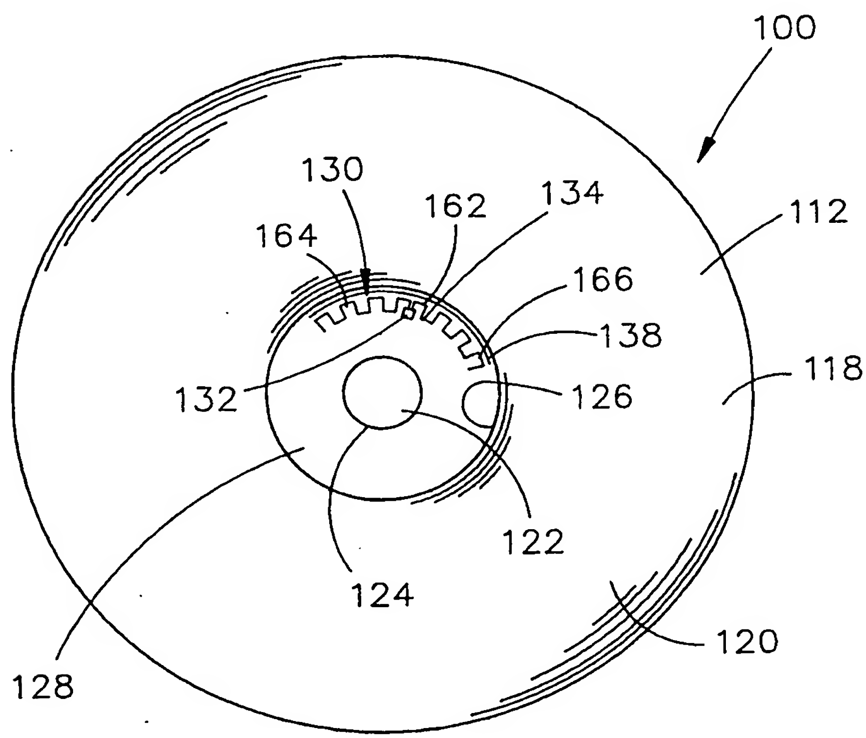
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FIG. 9

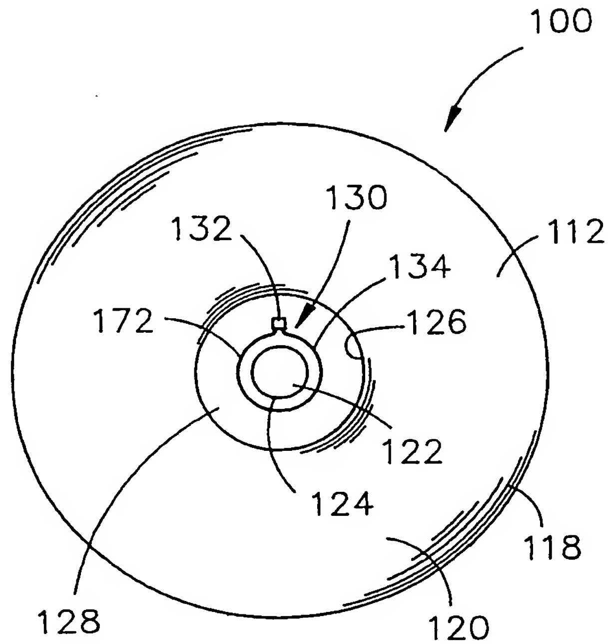

FIG. 10

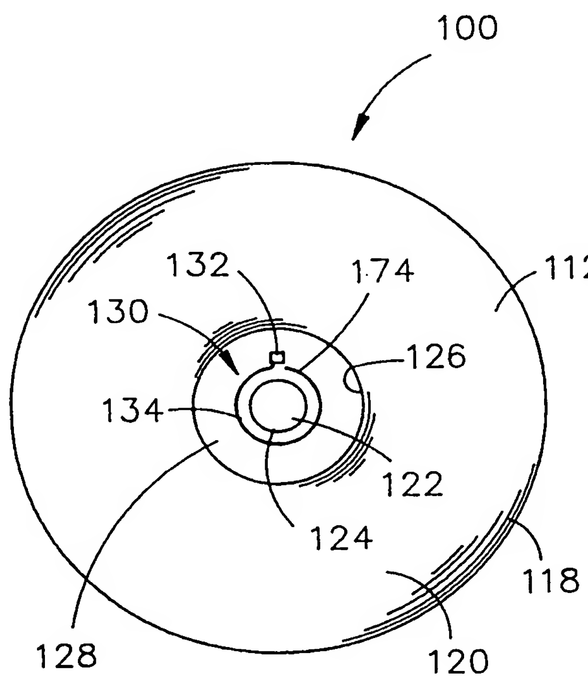

FIG. 11

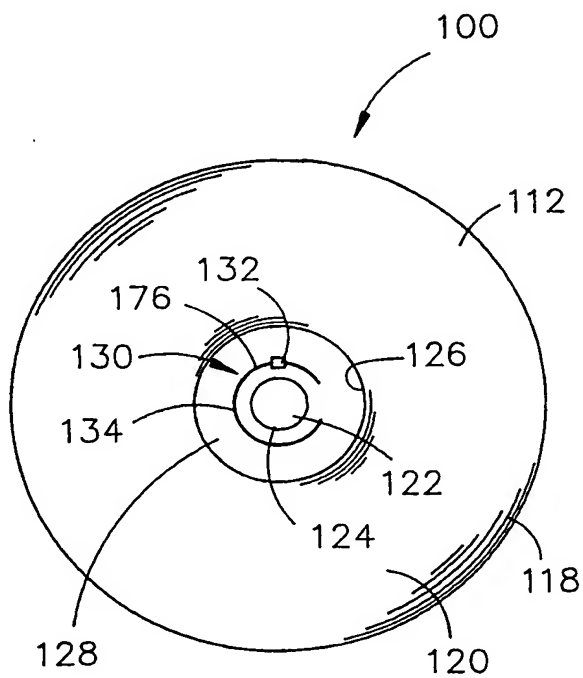

FIG. 12

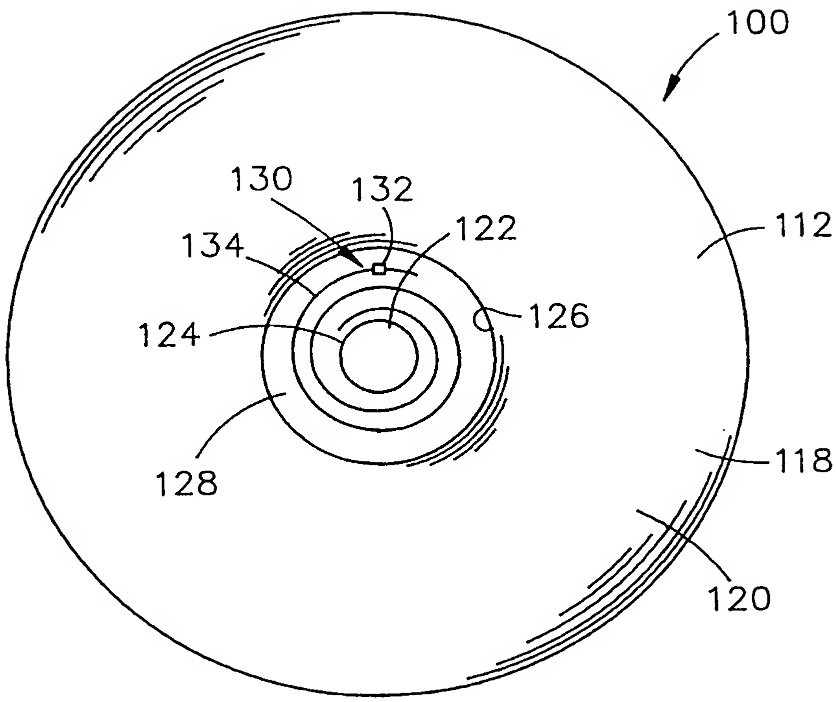
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FIG. 13

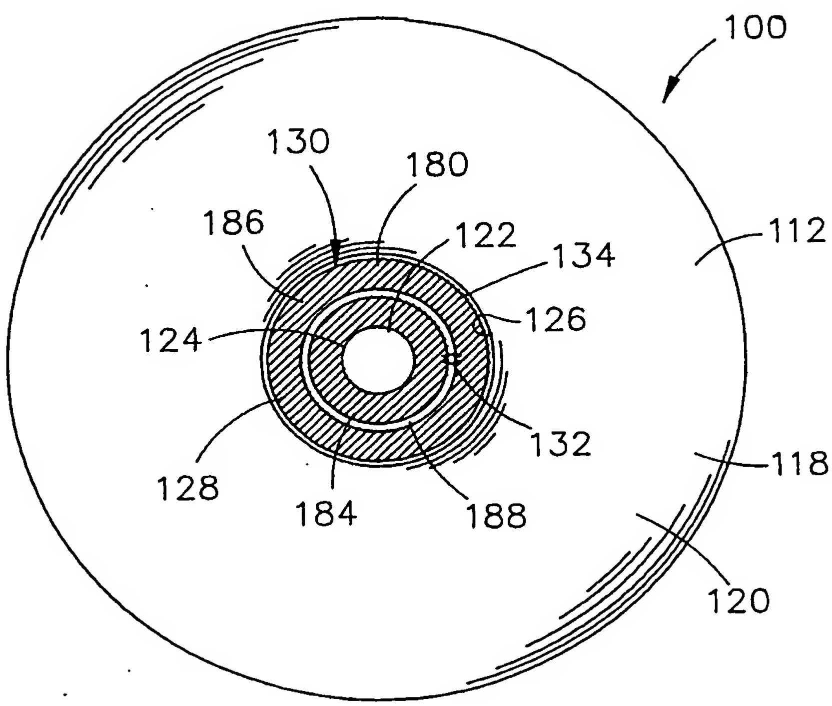
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FIG. 14

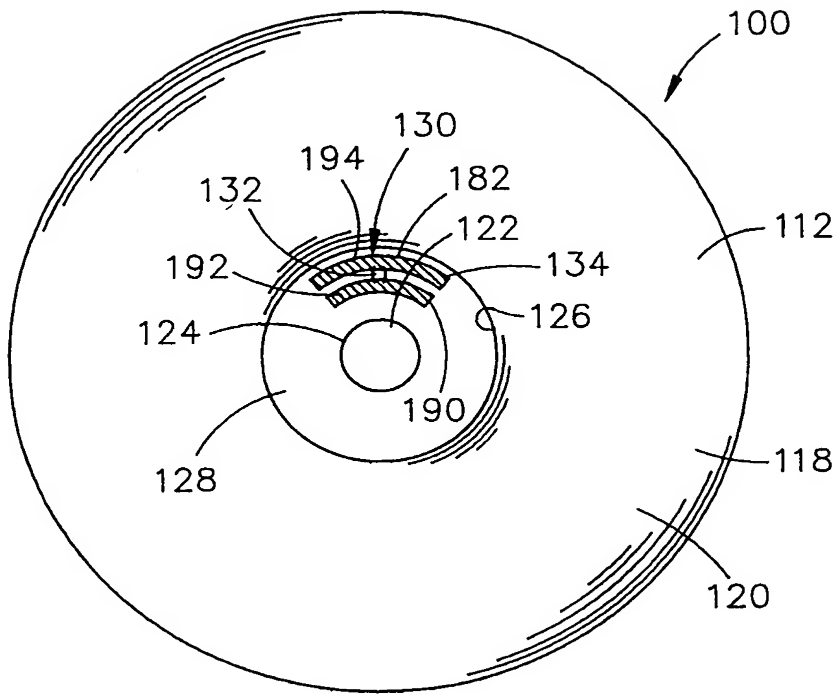
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FIG. 15

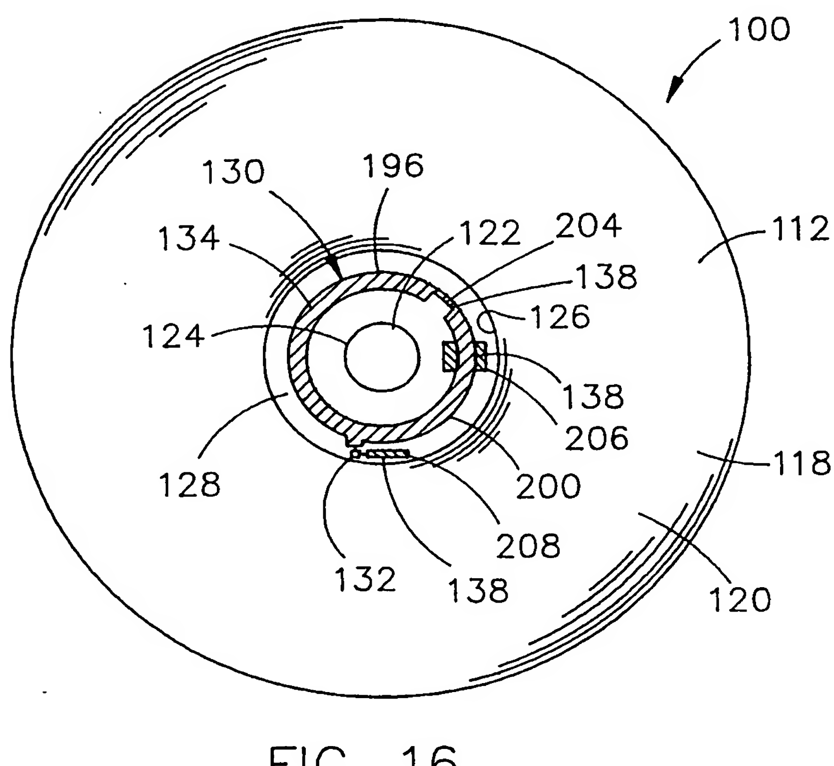
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FIG. 16

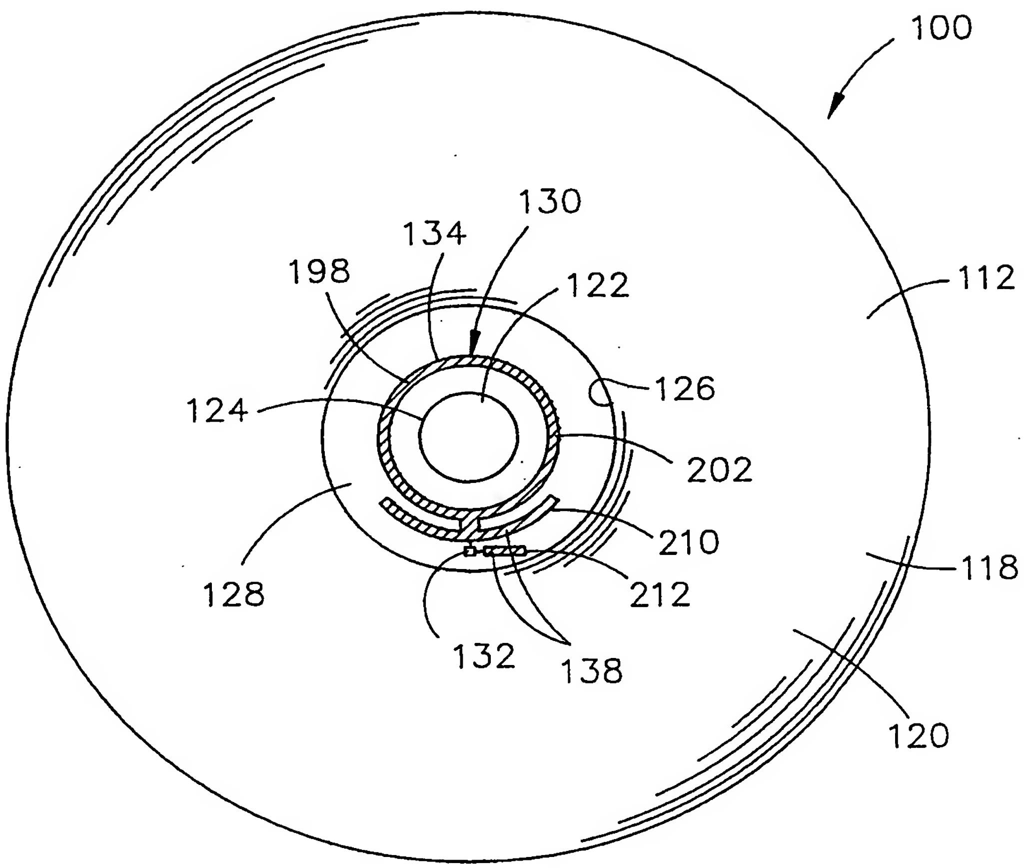

FIG. 17

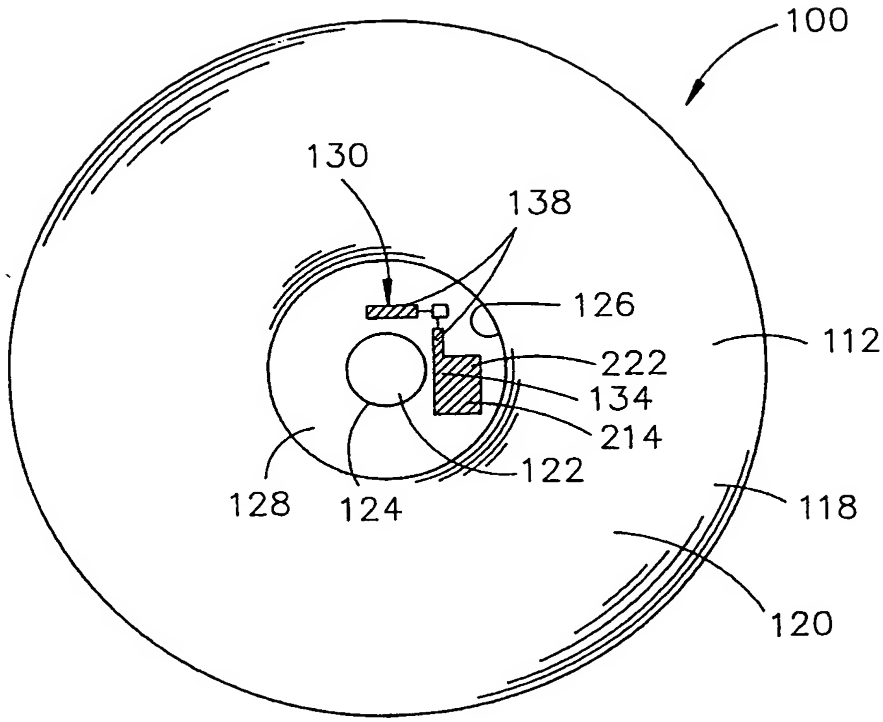
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FIG. 18

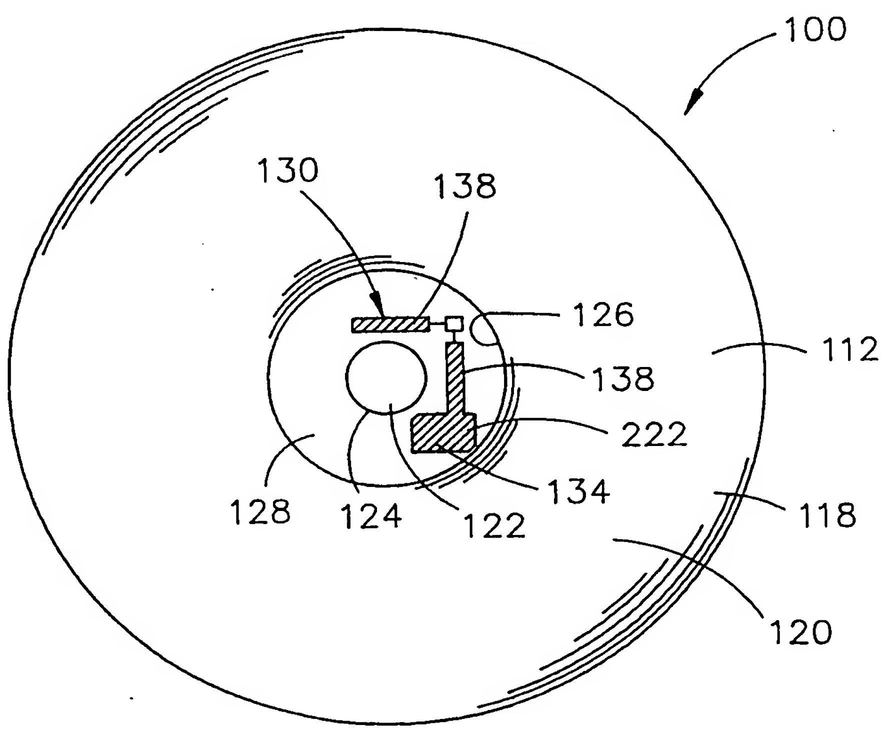
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FIG. 19

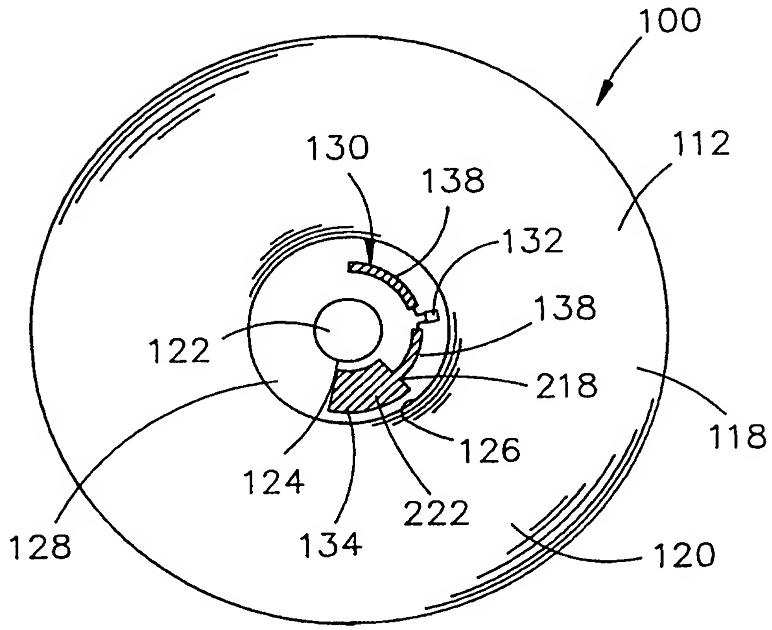

FIG. 20

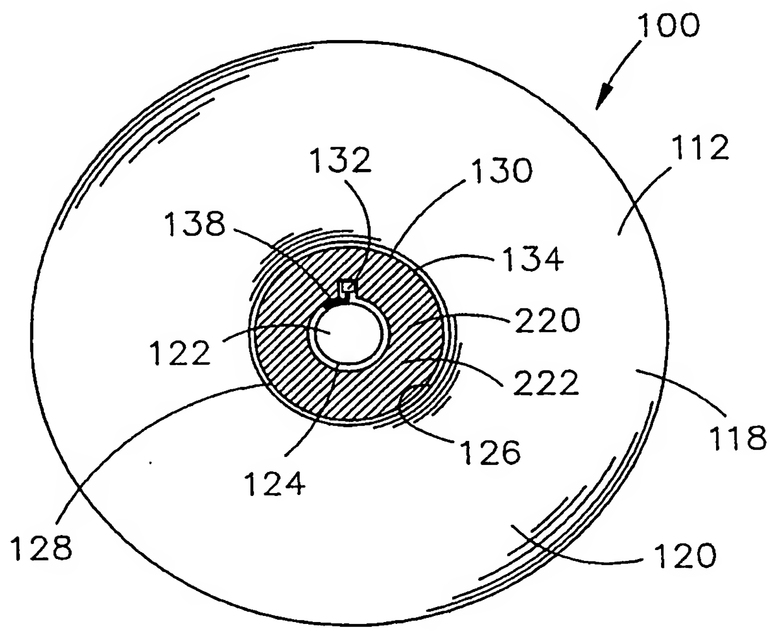

FIG. 21

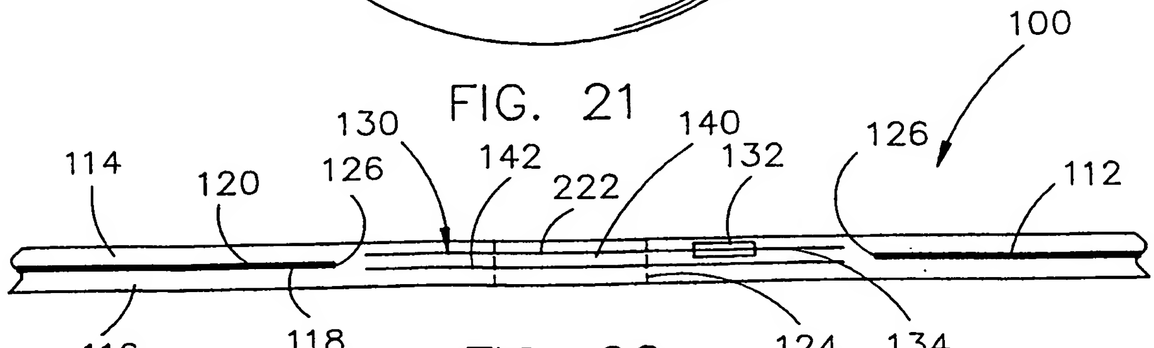

FIG. 22

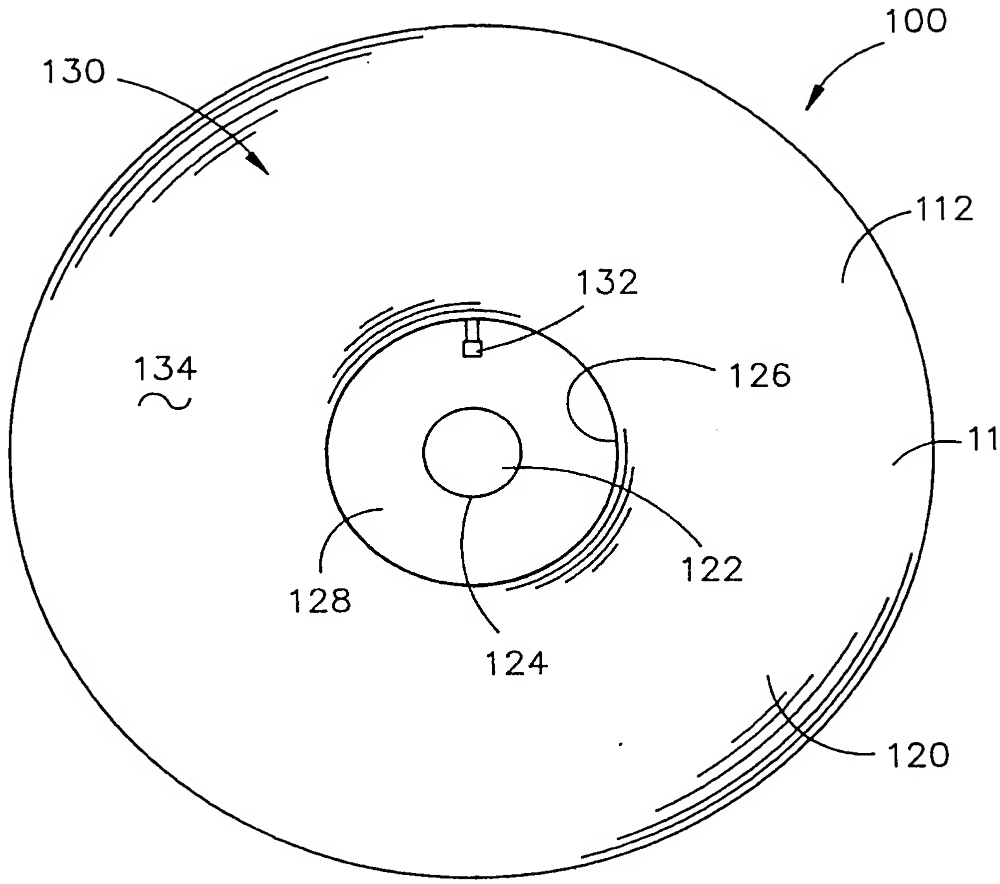
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FIG. 23

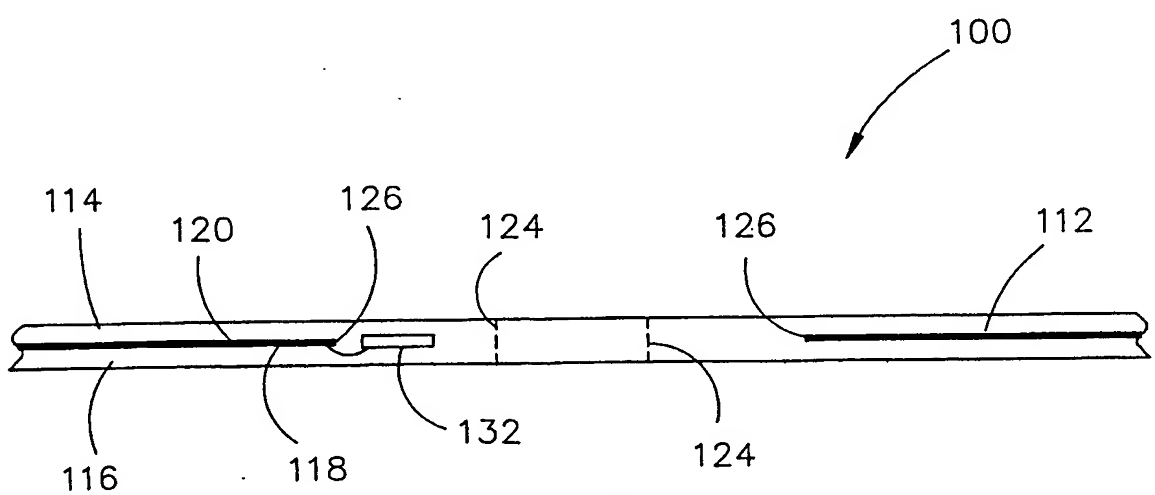
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FIG. 24

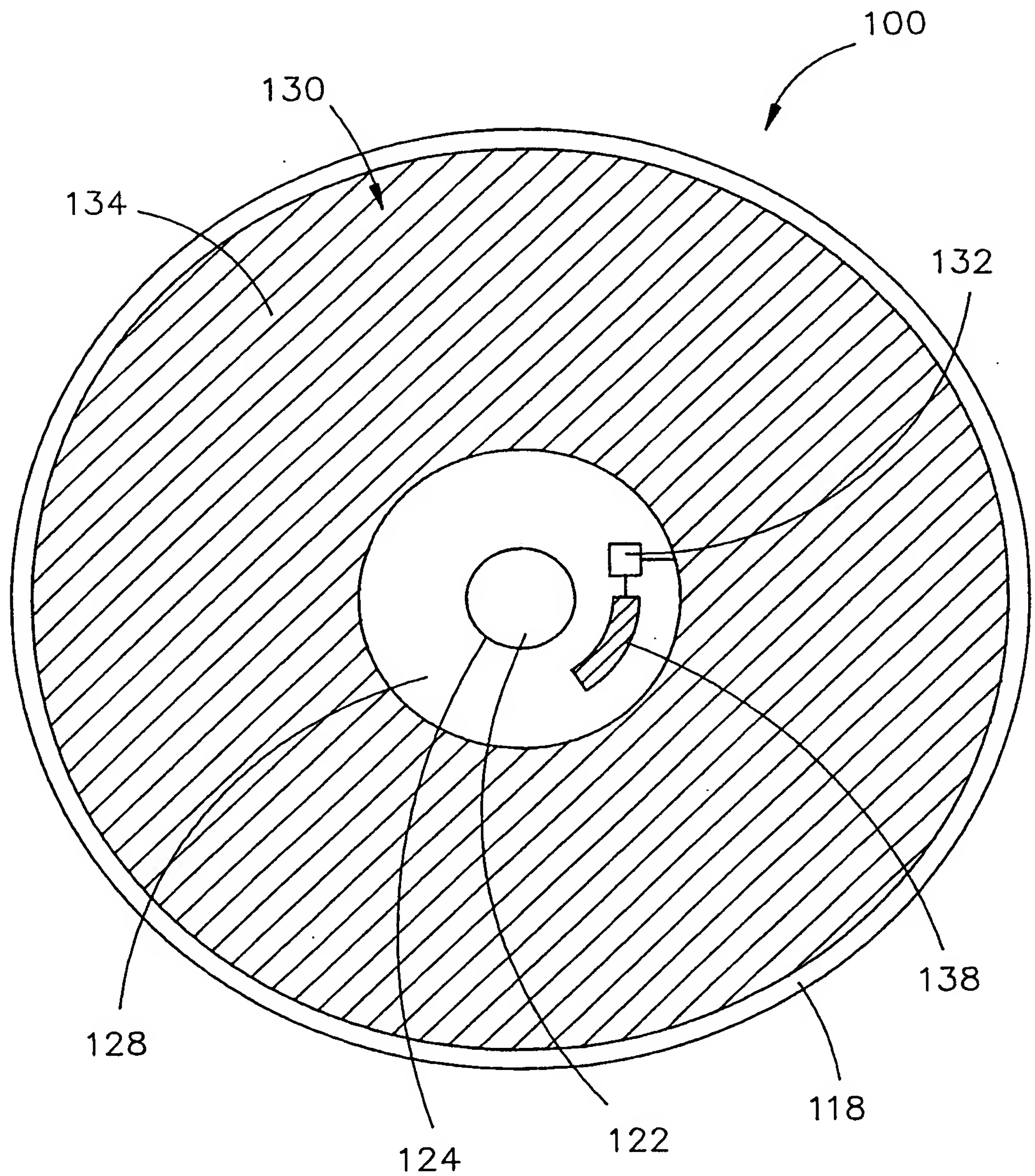

FIG. 25

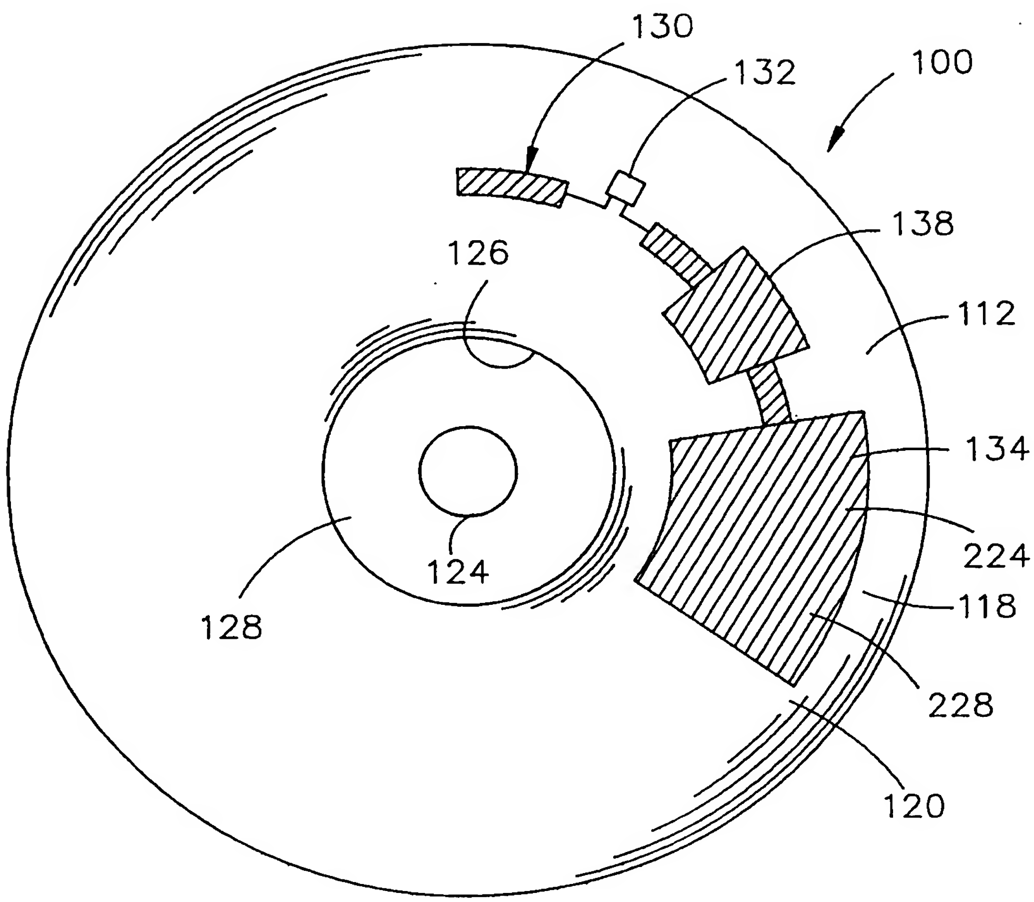
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FIG. 26

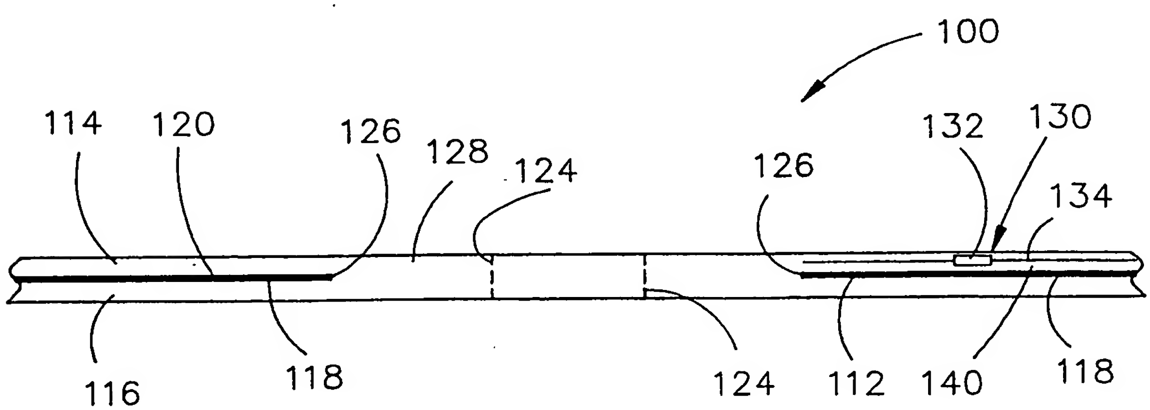
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FIG. 27

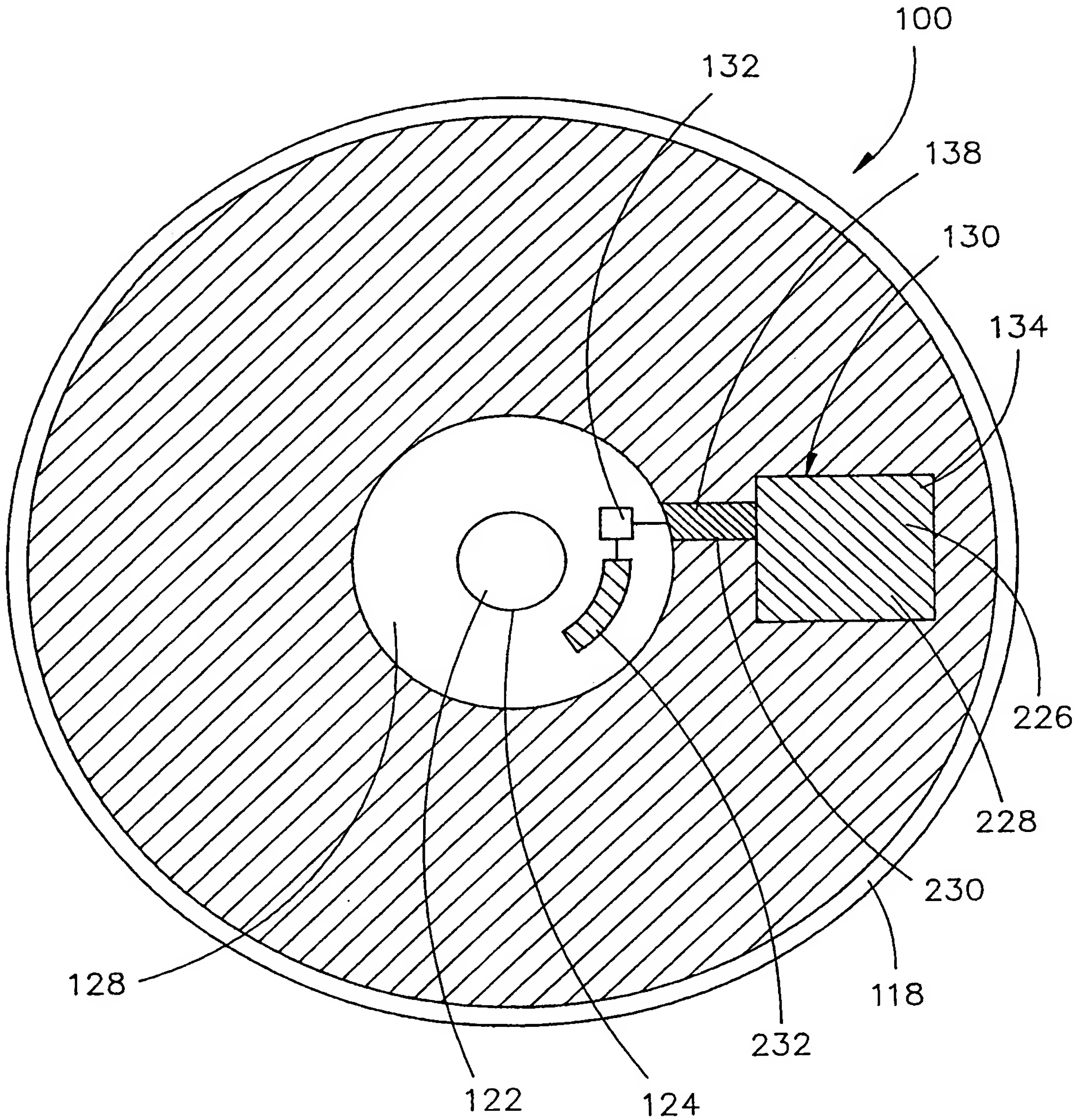


FIG. 28

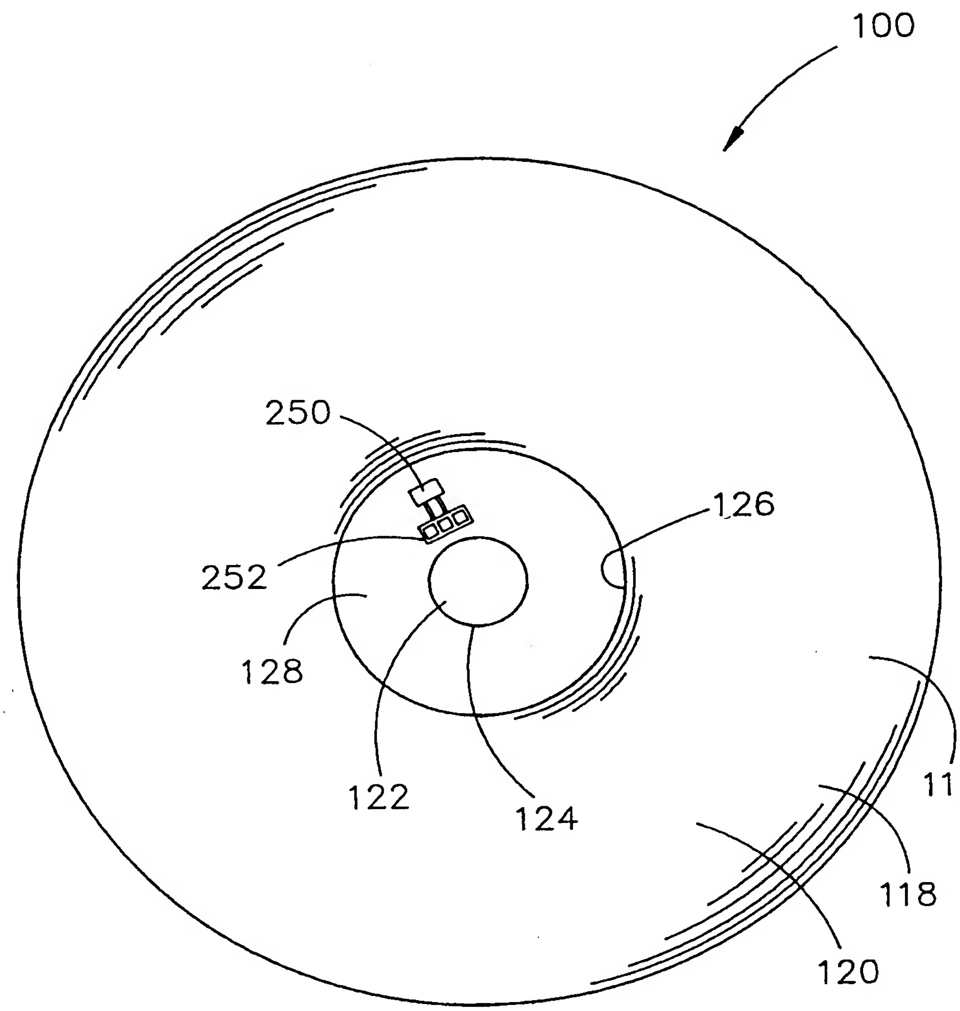
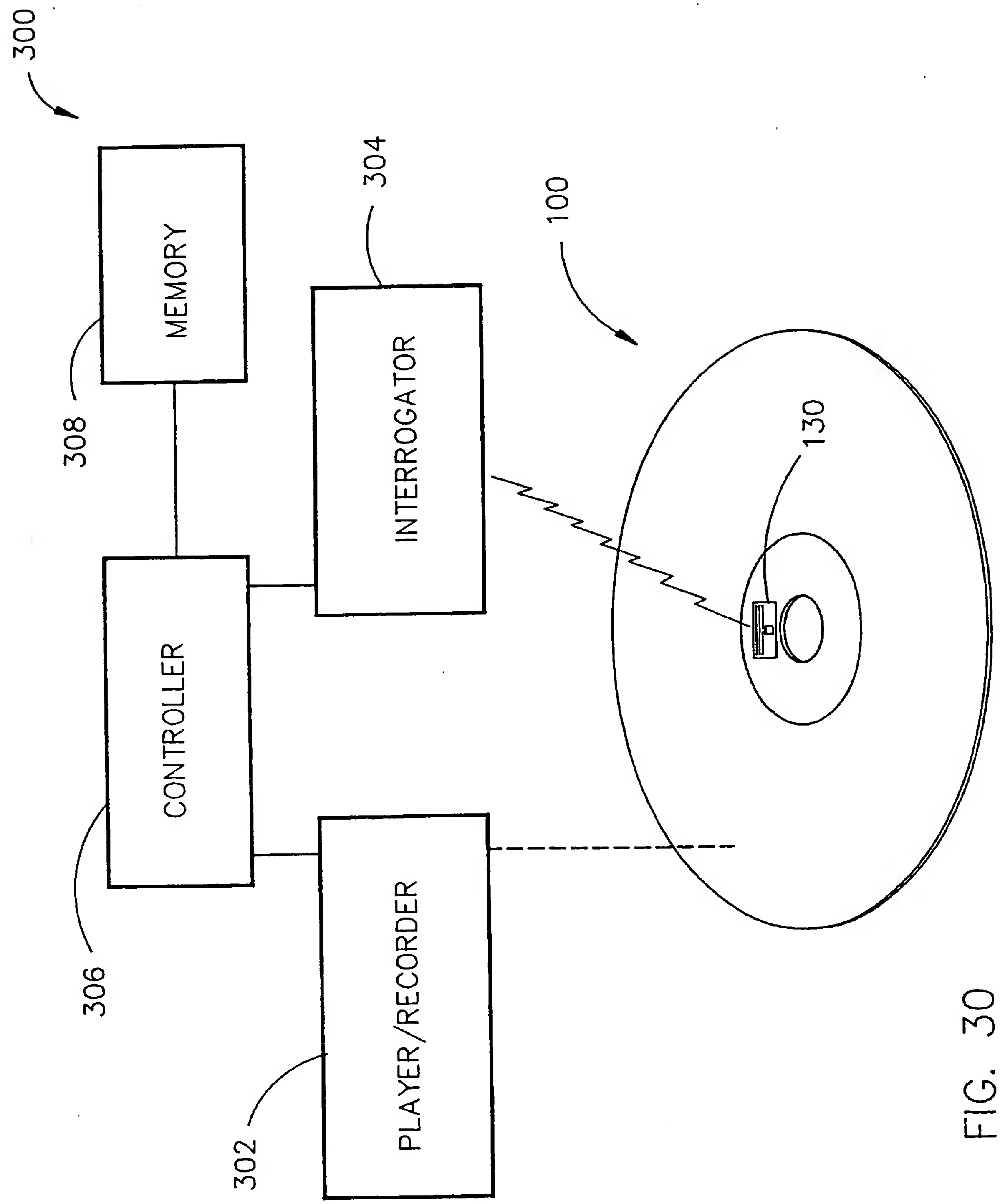


FIG. 29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INTERROGATOR
100
130
CONTROLLER
306
PLAYER/RECORDER
302

FIG. 30

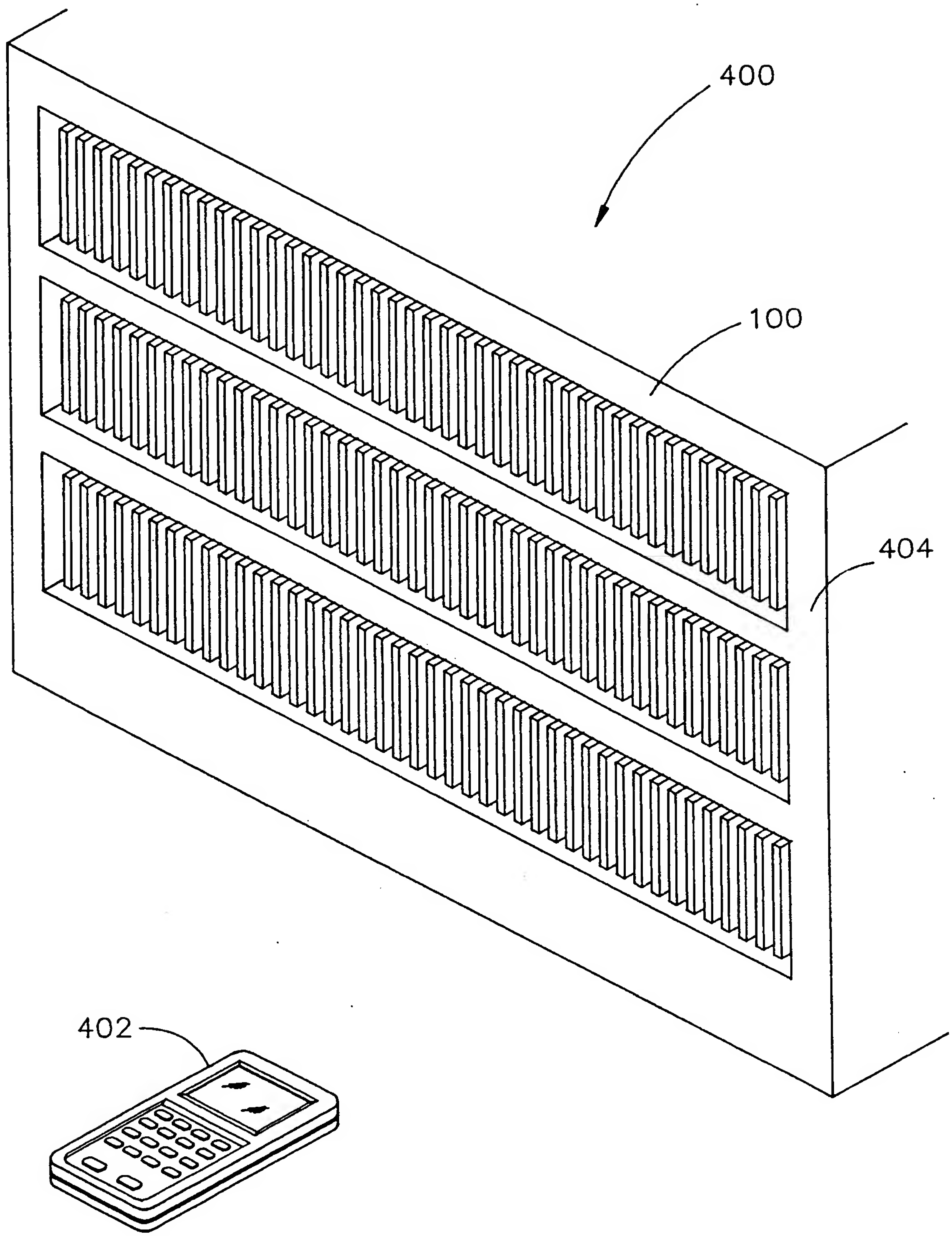

FIG. 31

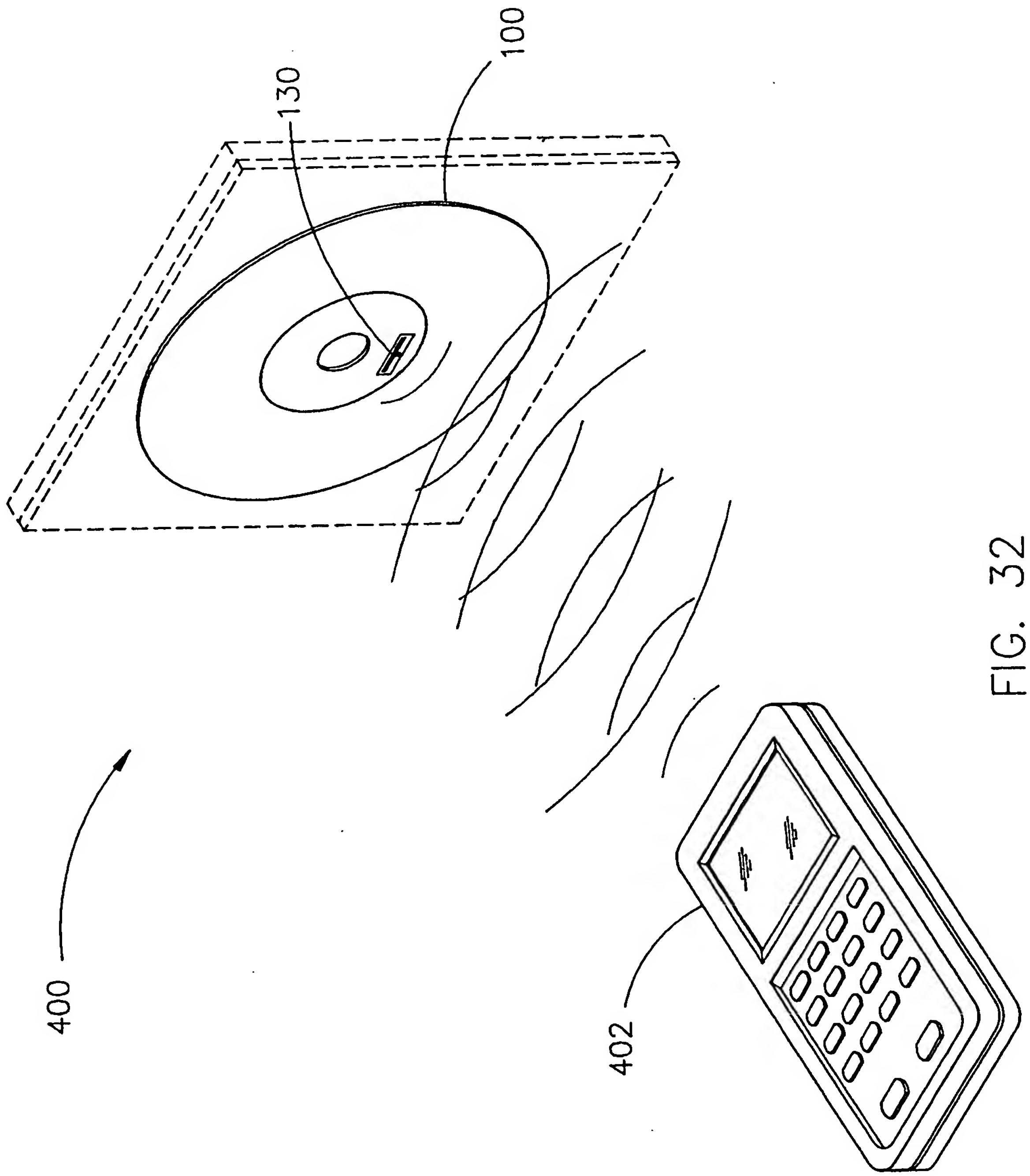

FIG. 32

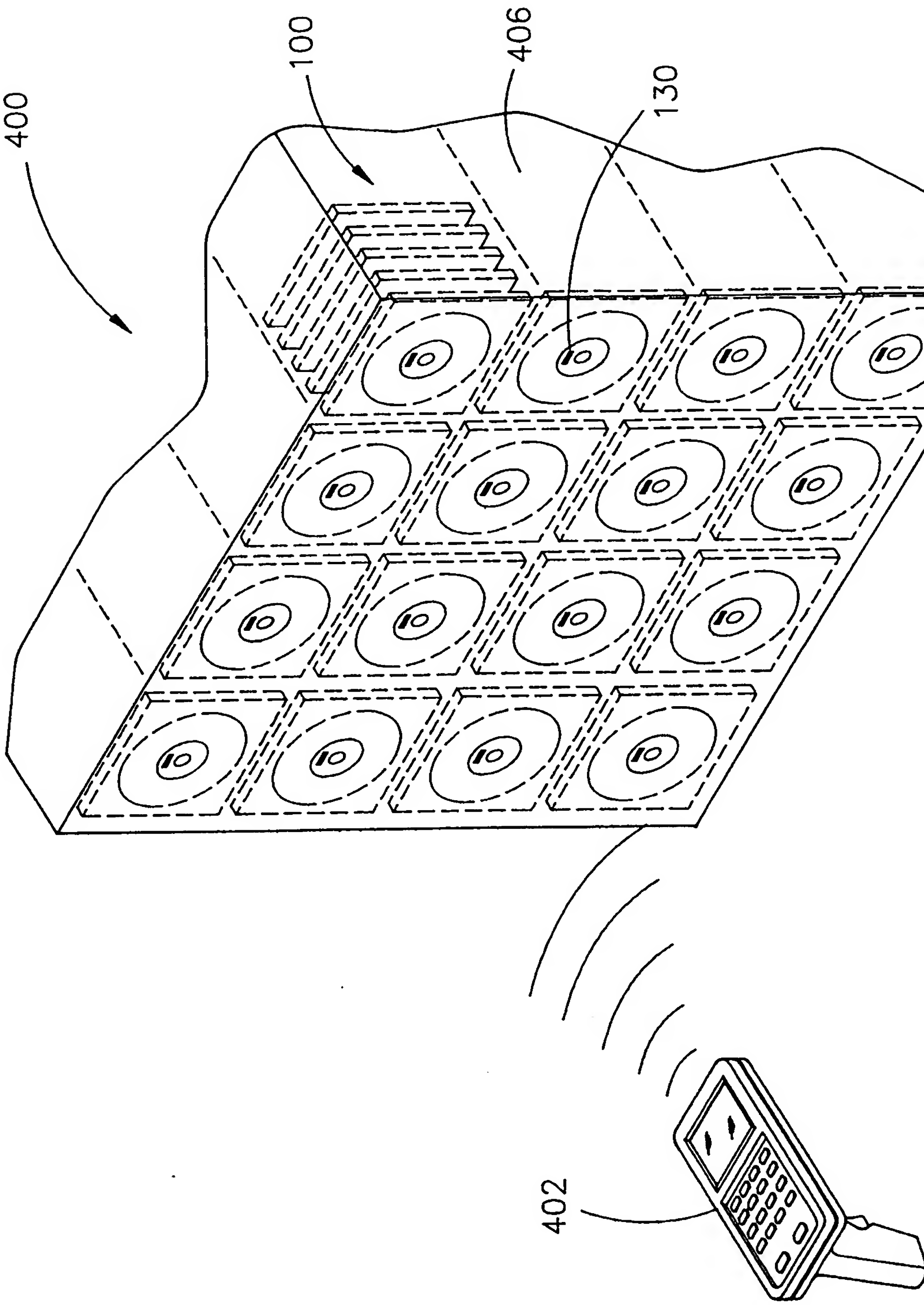

FIG. 33

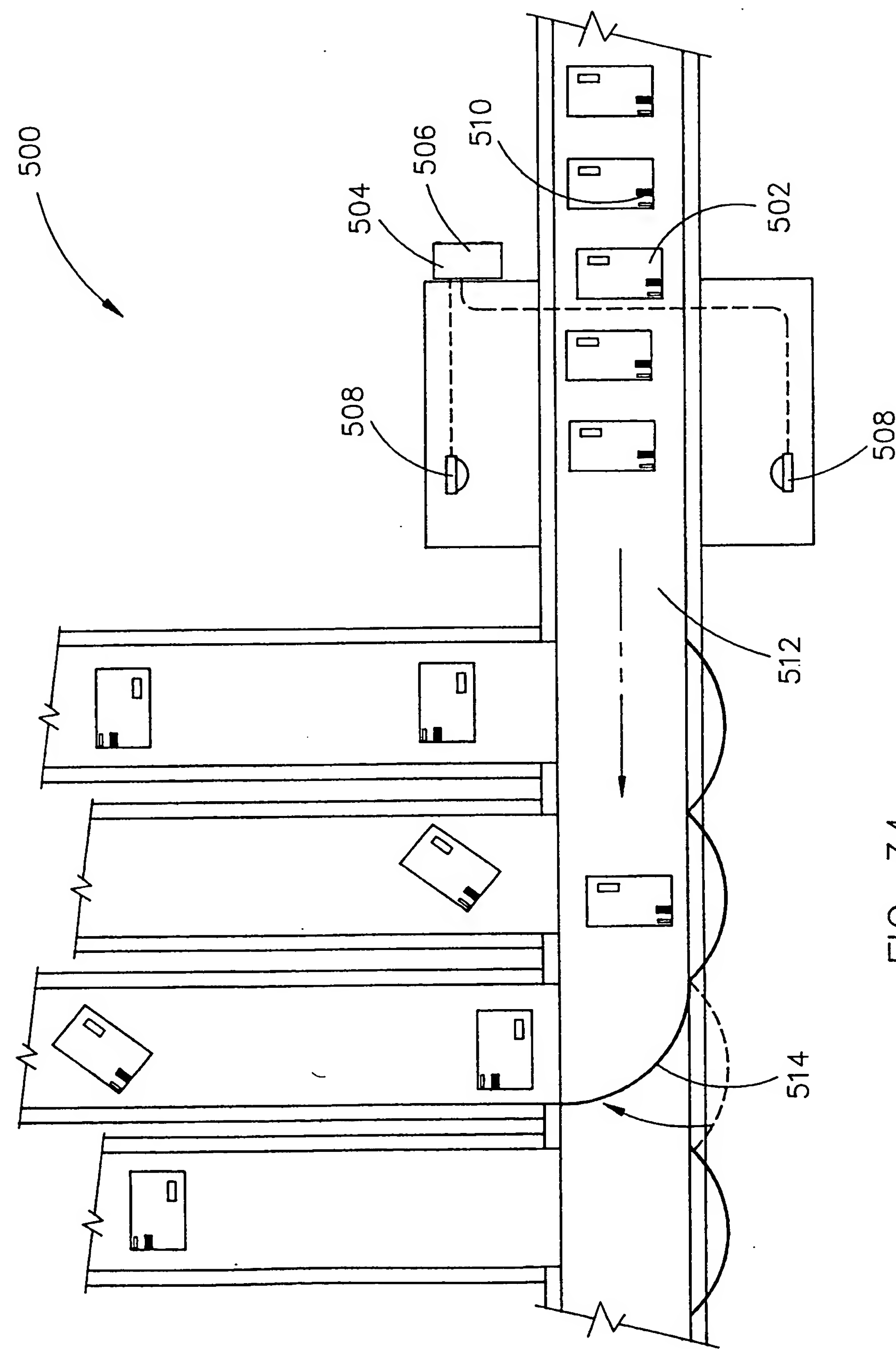

FIG. 34

INTERNATIONAL SEARCH REPORT

Intern ...al Application No
PCT/US 99/23630

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G11B20/00 G11B23/28 G06K19/07

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G11B G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 849 734 A (TEXAS INSTRUMENTS INC) 24 June 1998 (1998-06-24)	1,2, 5-17, 19-31, 35-37, 39-43, 45-47
Y	the whole document ---	38,44
X	EP 0 809 245 A (TEXAS INSTRUMENTS INC) 26 November 1997 (1997-11-26)	1,2, 4-17, 19-31, 35-37, 39,46,47
Y	column 1, line 12-39; figure 1	3
A	column 2, line 21-52 column 5, line 16 -column 7, line 20 --- -/--	34

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 January 2000	25/01/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Cardigos dos Reis, F

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5 119 353 A (ASAKURA TORU) 2 June 1992 (1992-06-02) column 4, line 59 -column 5, line 25	1,33 34,38,44
X	US 5 652 838 A (LOVETT DONNA M ET AL) 29 July 1997 (1997-07-29) column 7, line 24-36; figure 2	1
Y A	US 4 999 742 A (STAMPFLI JEAN-MARCEL) 12 March 1991 (1991-03-12) column 3, line 8-54; claim 1; figure 6	3 4,20
Y	WO 97 35273 A (FINN DAVID ;RIETZLER MANFRED (DE)) 25 September 1997 (1997-09-25) the whole document	34
A	US 5 786 626 A (FAVREAU NORMAND GILLES ET AL) 28 July 1998 (1998-07-28) column 9, line 21-42	6,19
A	US 5 309 163 A (NGAN YIU C ET AL) 3 May 1994 (1994-05-03) the whole document	7-9, 11-14, 17,23, 27,29,31
A	US 5 182 570 A (NYSEN PAUL A ET AL) 26 January 1993 (1993-01-26) the whole document	10,28
A	WO 93 00724 A (UNITED KINGDOM GOVERNMENT ;UNIV MANITOBA (CA)) 7 January 1993 (1993-01-07) page 9, line 29 -page 10, line 27; figures 1-13	15,16,26
A	US 5 258 762 A (CABON PHILIPPE ET AL) 2 November 1993 (1993-11-02) abstract; figure 13	24,25

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter. ·nal Application No
PCT/US 99/23630

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			WO	9010200	A	07-09-1990
			JP	3504433	T	26-09-1991